Orbit

The Journal of the Radio Amateur Space Program

No. 7

May/June 1981
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Published by AMSAT — The Radio Amateur Satellite Corporation

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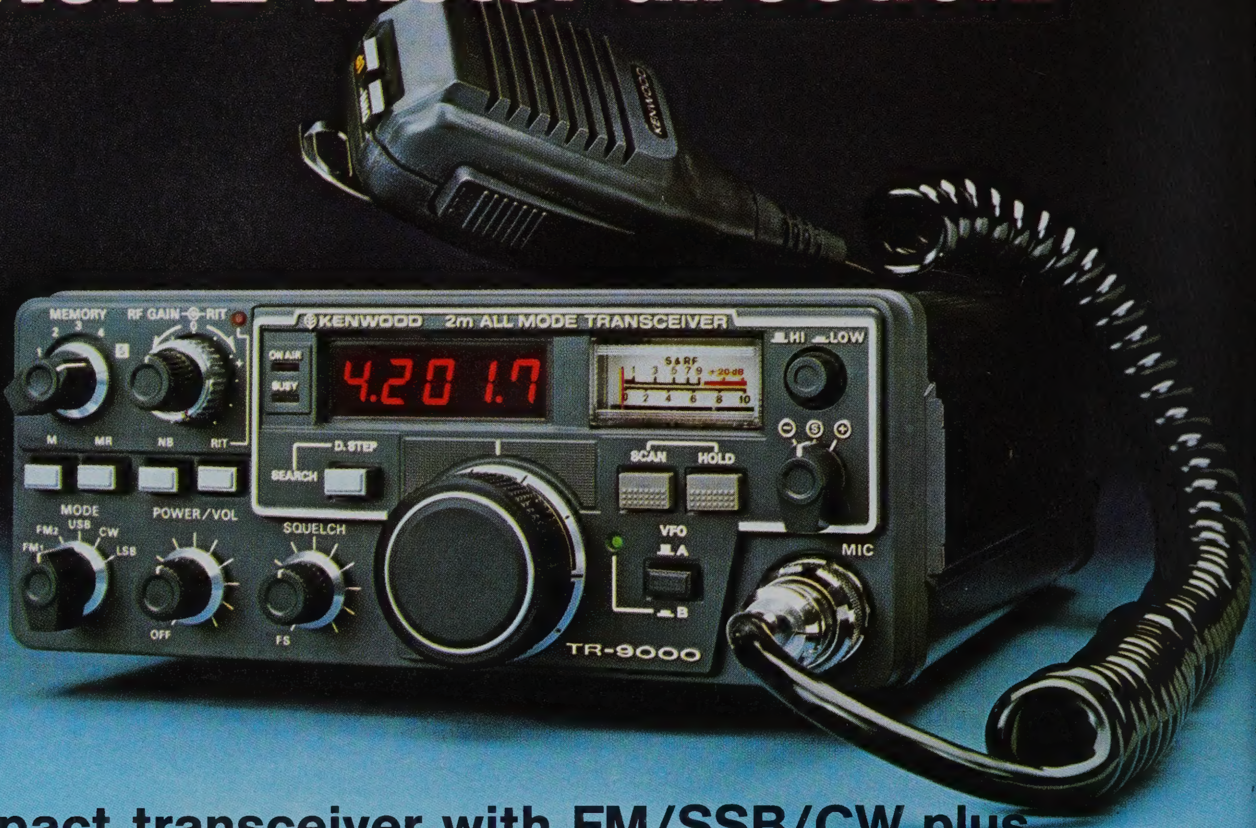

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TR-9000 FEATURES:

- **FM, USB, LSB, and CW**
  All the popular 2-meter modes.
- **Extended frequency range**
  Covers all 2-meter Amateur frequencies as well as MARS and CAP frequencies (simplex and any repeater split) between 143.9000 and 148.9999 MHz.
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  With selectable tuning steps of 100 Hz, 5 kHz, and 10 kHz, convenient for each mode of operation.
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  Only 6-11/16 inches wide by 2-21/32 inches high by 9-7/32 inches deep.
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  With quick-release levers for easy removal.

More information on the TR-9000 is available from all authorized dealers of Trio-Kenwood Communications, Inc., 1111 West Walnut Street, Compton, California 90220.

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Specifications and prices are subject to change without notice or obligation.

Orbit

May/June 1981
Volume 2 Number 3

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Advertising Director: Roger Soderman, WA2NFJ
Associate Editors: Harry Bluestein, N6TE, Roy O. Hill, W4PID

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Office Manager: Martha Saragovitz
Treasurer: Roy Rosner, K4YV

Editorial Office: 850 Sligo Ave.,
Silver Spring, MD 20910.
Telephone: 301 589-6062
Advertising Office: 221 Long Swamp Road, Wolcott, CT 06716
Telephone: 203 879-1869
AMSAT: P.O. Box 27, Washington, DC 20044.
Telephone: 301 589-6062
Telex: 248-566

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The *AMSAT Newsletter* chronicled the Radio Amateur Space Program from 1969 through 1979. It contains many articles that are of timely interest today: spacecraft technical descriptions, ground support equipment, operating news and the like. A few are still available. Random selection of 15 different issues for $15.00 postpaid from *ORBIT,* 221 Long Swamp Road, Wolcott, CT 06716, U.S.A.

Our Cover: Martin Sweeting, G3YJO, steadying the UoSAT Spaceframe as it is lowered on to the shake table before vibration tests. This photograph was taken during tests held at British Aerospace in November 1980.

SATELLITES & 73

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*Low-Cost Receiver for Satellite TV—this modular design uses readily available technology.

*The Europa-B Two Meter Transverter—work OSCAR and 2m SSB with this British import.

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*AMSAT—keep up with the organization's monthly news

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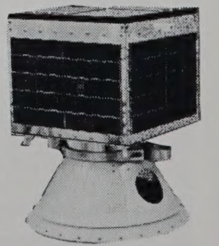
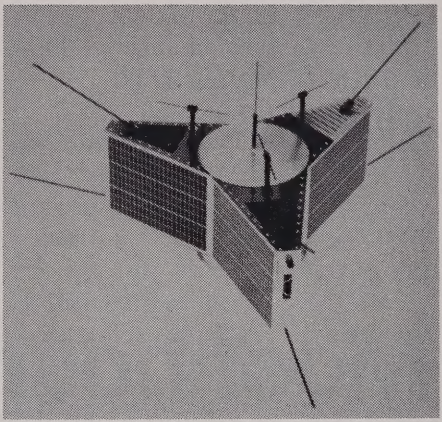


OFF THE PAD

First Stage Separation

By Joe Kasser, G3ZCZ



The *AMSAT Newsletter* was a quarterly journal published by the Radio Amateur Satellite Corporation (AMSAT) from its foundation in 1969 until its metamorphosis into *ORBIT* Magazine in January 1980. With the help of its readers, the quality of the contents of the *Newsletter* gradually improved over the years until it was winning an Amateur Radio News Service (ARNS) award annually. Finally, as of 1980, the AMSAT Board of Directors discontinued the publication of the *Newsletter* and instigated the publication of *ORBIT* Magazine, to continue to publicize and document the achievements of the Radio Amateur Space Program: a diverse set of space related Amateur Radio activities, and the AMSAT organization.

Slowly, over years the costs of producing the publication increased. *ORBIT* Magazine contains advertisement, the *Newsletter* did not. It is these advertisements that are supposed to cover the difference in cost to the organization between publishing the *Newsletter* and *ORBIT*. Thus, as each issue of *ORBIT* appears, its increased circulation and advertising content will enable AMSAT to bring you a professional journal at an equivalent or lower cost to the organization of a newsletter, and also increase the frequency of publication to six times a year.

You, the member, will gain by receiving a quality publication more often. The organization also gains because its publications costs are lower, but you have to do your part to make this scenario take place. Although a number of members have indicated their pleasure with the contents and style of the *Newsletter* and *ORBIT*, to me as Editor, the most disappointing aspect of the job has been *what has not been published* in the pages of the publications. For example, very little has appeared in print to document the experiments performed on Wednesday, yet one in every seven days is an experiment day. The absence of such literature has caused many new (and some old) members to question the validity of even continuing to have an experiment day, whereas some of these experiments (such as the Emergency Location Transponder tests for locating downed aircraft) have been truely pioneering and have been recognized as such by the professional community.

It is these photographs and articles that have not been published because they were not submitted that have most disappointed me in my position as Editor of AMSAT's publication. That is *not to say* that *ORBIT* is the only place to publish space related Amateur Radio articles because obviously it is not. I would however like to point out that they (or similar articles) can be published in *ORBIT* as well.

As a member of AMSAT and a reader of *ORBIT*, you have an obligation to contribute to the success of the magazine. You can contribute articles, photographs and operating activity news. Roy, W4PID can perform miraculous transformations on submitted material and can turn almost anything into a readable article. Pat, G3IOR recently commented that he thought that Radio Amateurs in the U.S.A. were mostly illiterate because he had received hardly any inputs from the U.S.A. for his column. Is he correct? I've felt the same way many times when no comments are received back about the contents of the magazine. Did anyone read my editorial in *ORBIT* 5 that introduced the Phase IV concept? No one has commented on it to me.

After having guided *ORBIT* Magazine from its launch in January 1980 to this, the seventh issue, the parting of the ways is at hand. My personal decision to relocate from Silver Spring, Maryland and convert G3ZCZ/W3 to G3ZCZ/4X makes it impractical to continue in my position as Editor of AMSAT's publication, a position that I have held since December 1974, and so, reluctantly, I am stepping aside and transferring that mantle (burden?) to the shoulders of someone else. That does not mean however that my contributions will end. The G3ZCZ (or 4X equivalent) byline *will* continue to appear in these pages.

The experience and knowledge gained during the launch phase of the magazine will be transferred to the new editor who will stamp his personality on these pages much as I have stamped mine therein. With your assistance after a short transition phase we will have a successful second stage firing that will continue the *ORBIT*.

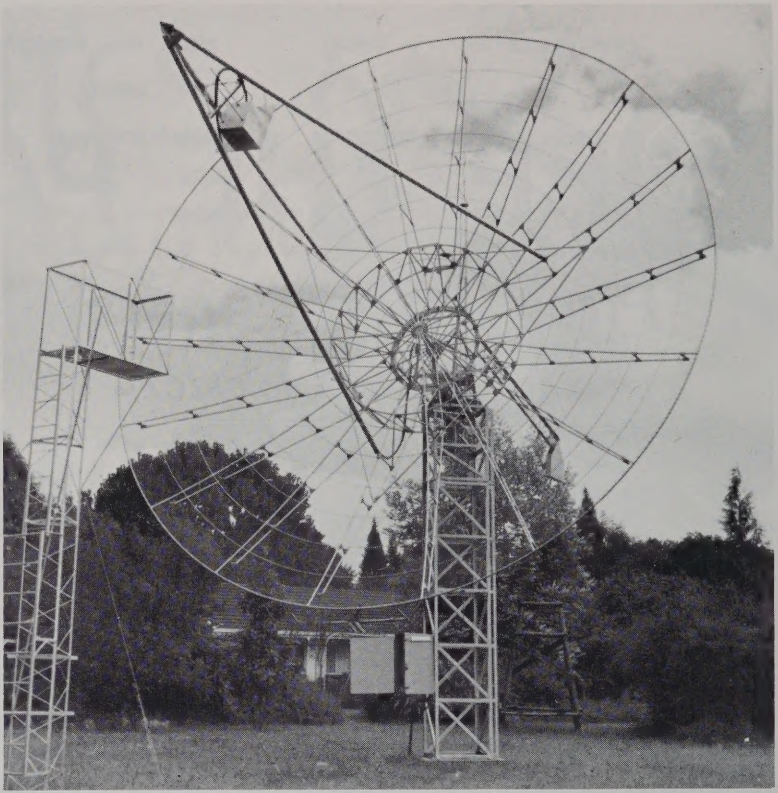
Finally, before I lay down my editor's pencil and pick up my contributor's word processor I'd like to thank those of you who have taken the time to communicate with me about the publications and Bob, W1XT, without whose knowledge, experience and efforts, there would have been no magazine.

Let us all do our part to assure that the second stage burn is successful and this journal really does go into *ORBIT*.

Earth-Moon-Earth Communications (E.M.E.)

Moonbounce

By W.S. Carey,**ZE5JJ



There is always a right way to go about anything difficult and, unfortunately, there is a wrong way. In the case of moonbounce, the wrong way leads to wasting time, energy, equipment and, regrettably, money which is a commodity we all seem to be short of. Therefore, my advice to anyone embarking on EME is to listen to the people who are succeeding, for most of them have been through the various stages. And, above all, talk to them.* Don't be shy about it, for you will likely find that they are only too keen to advise, help and assist in any way possible and within their capabilities.

Personally, in retrospect, I went about it the wrong way. I tried to "go it alone" and the net result was loss of time, wasted effort and after eight years I could only claim that I had achieved moonbounce on three occasions, which was quite appalling, to say the least!

What is EME all About and Why Do it All?

These are questions I am often asked. Anyone can go out, buy a good hf rig and a triband beam and immediately have QSO's with any part of the world. But what satisfaction really is there in doing this? There is no challenge at all in following this approach and so, in a nutshell, my answers to these questions are:

1) EME provides an enormous engineering challenge.
2) It is so complex the interest is maintained.
3) Besides EME itself, a good station can quickly be adapted to the study of Radio Astronomy, a very diverse and exceedingly interesting field.
4) Because it is difficult, man desires to do it.

For those who don't appreciate what EME really does, let me say that it is a communication link between two stations on earth which can only be established when the moon is employed as a reflector, albeit a very poor one. So, theoretically, for 12 hours a day, two stations could communicate via the moon, no matter what the weather or ionospheric conditions are (under normal circumstances!). What more could one wish for? You cannot do this on hf!

What are the Minimum Requirements to Establish Reliable EME Communication on 432 MHz for Example?

1) The ability to hear 8 dB or more sun noise referenced to cold sky through the receiving system.
2) The antenna should have at least 24 dB gain above isotropic.
3) The transmitter output power should be in excess 500 watts and this should be a clean carrier; i.e., no chirp or hum on it.
4) The first low-noise amplifier should have a noise figure of less than 1.5 dB (equivalent to a noise temperature of 120 degrees Kelvin).
5) The antenna should be remotely controlled and able to track the moon without it being visible.
6) Stability of the receiving and transmitting systems should be the same or better than a crystal controlled reference oscillator.
7) Some means of accurately measuring frequency at the carrier level is a distinct advantage.

**The Moonbounce Net meets Sat. and Sun. on 14,345 kHz at 1600Z.*

***10 Fairway, Northwood, Mt. Pleasant, Salisbury, Zimbabwe*

The list may appear formidable, but it is not all that bad. Modern day techniques, especially in the solid-state field, make it possible and practicable to meet the more difficult tolerances.

Types of Antennas

For two meter moonbounce the most popular antennas are Yagis, Quads, Quagis and Collinears. All of these have feed problems, but fortunately the frequency is not high enough to introduce constraining losses to any extent.

For 70-cm moonbounce, there is a definite trend or pattern emerging. Of course the parabolic dish is very popular, indeed, because of its versatility, but in later years multi-Yagi and Quagi arrays have been built, especially in areas where there are high winds, icing, or snow. This is obvious because of the reduced area affected compared with the dish.

For 23-cm moonbounce I don't know of anyone trying to do EME with anything other than a dish and it is at this frequency that even the small dishes can shine. Of course enthusiastic people are always trying out new types of antennas with all their various forms but not with great success.

The Yagi is the cheapest, but not the easiest to adjust for optimum performance, especially in the multi-element and multi-Yagi arrays. There are severe loss problems whether one uses coaxial cable or open-wire feed lines and, unfortunately, although theoretically the latter are not so lousy, it has been found that severe losses do occur across the transmission line spacers in misty/wet weather. This may be reduced by minimizing the number of spacers and placing them at voltage minima, but it is difficult nevertheless. So the trend is to use a dish, even in places where snow and icing conditions prevail, because of its inherent simplicity and ease of adjustment.

What is the Meaning of Path Loss and the Range Elevation?

It is necessary to appreciate the enormous losses present in the path to the moon to be able to understand why it is that there is a minimum antenna gain, transmitter power output and maximum noise figure for the receiving system.

To illustrate how important the path loss and range equations are to the understanding of EME, it is necessary to define their components as follows:

P_o - Transmitter output power
L_t - Transmitter feedline loss
G_t - Effective antenna gain in transmit
G_r - Effective antenna gain in receive
T_a - Receiving antenna temperature (°K)
L_r - Receiving feedline loss
T_L - Temperature of receiving feedline (°K)
T_r - Receiver input temperature (°K)
R - Distance between the centers of the Moon and the Earth in statute miles (≈250,000 miles)
d_m - Diameter of Moon (scattering aperture in statute miles (2160 miles)
λ_o - Free space wavelength in statute miles
σ_m - Moon reflection coefficient (0.065) in the VHF/UHF spectrum

The path loss (P_L) is then defined as:

$$P_L = \frac{\text{Power Received}}{\text{Power Transmitted}} = G_t.G_r \left[\frac{dm^2\,\lambda_o^2\,\sigma_m}{(16\pi)^2\,R^4}\right]$$

The bracketed term is the "free space loss" between ground station antennas with $G_t = G_r = 1$ (for an isotropic antenna) and this calculates to the following values at various frequencies:

Frequency (MHz)	Free Space Loss ± 1 dB between isotropic antennas (dB)
144	−252.4
432	−261.9
1296	−271.4
2300	−275.8

The ±1 dB variation accounts for differences in range (R) due to the Moon's eliptical orbit around the Earth.

The Range equation makes use of the Path Loss (P_L) to compute the expected echo level received back on Earth from a transmitted moonbounce signal and is as follows:

Received power level (P_S) dBm $= P_t - L_t + (G_t + G_R) - P_L$

Consider some typical levels. The following conditions are typical for a 32-foot diameter dish.

P_t = 500 watts or +57 dBm
L_t = 1 dB or 1.26 Tx feedline loss
G_t = G_r = 40 dBi (dB above isotropic)
T_a = 20°K for a good horn antenna near zenith at 1296 MHz
L_r = 1 dB or 1.26 Rx feedline loss at 290°K
T_r = 1 dB noise figure ≈75.4°K for a good preamplifier front end
B = 110 Hz receiver audio bandwidth
T_L = 293°K

Using these values,

$P_s = +57 \quad - 1.0 \quad + 80 \quad - 271.4$
i.e., $P_s = -135.4$ dBm ....(1)

The receiver noise power (P_w) can be computed from the following equation:

$P_w = KT_{system}\,B$ dBM
where K is Boltzmann's constant (1.38×10^{-23} W/Hz − °K) and
T_{system} is given by the equation
$T_{system} = T_a + (L_r - 1)\,T_1 + L_rT_r$ so,
$T_{system} = 20° + (1.26 - 1)\,293 + 126\,(75.4)$
i.e., $T_{system} = 190.4°K$ ....(2)
Now P_w can be written in a more convenient form; i.e.,

$$P_w = K\,T_{system}\,B = K\,T_o\,\frac{T_{system}}{T_o}\,B$$

where $T_o = 290°K$ and KT_o computes to −174 dBm/Hz in the 110 Hz bandwidth and so in decimal form P_w becomes

$$P_w = -174 + 10 \log_{10} \frac{190.4}{290} + 10 \log_{10} (110) \text{ dBm}$$

i.e., $P_w = -174 + (-182) + 20.4$

$P_w = -155.42$ dBm ....(3)

Now the signal-to-noise ration (SNR) $= \dfrac{\text{Received Signal Power } (P_S)}{\text{Receiver Noise Power } (P_L)}$

in decibel form, SNR $= P_S - P_w = -135.4 - (-155.42)$

SNR $= +20.02$ dB ....(4)

So, for 500 Watts of output power the SNR is + 20.02 dB

50 Watts of output power the SNR is 10.02 dB

5 Watts of output power the SNR is 0.02 dB

It is thus obvious that for effective echo levels a power input of at least 50 Watts into a 32-foot dish is necessary since the minimum usable SNR is about 4 dB.

Now consider the effect of reducing the receiver feedline losses to zero; namely, let $L_r = 0 \text{ dB} = 1.0$. In this case,

$T_{system} = 20 + 75.4 = 95.4°K$, therefore

$$P_w = -174 + 10 \log_{10} \left[\frac{95.4}{290}\right] + 10 \log_{10} (110) \text{ dBm}$$

$= -174 - 4.8 + 20.4;$

i.e., $P_w = -158.4$ dBm

and since SNR $= P_S - P_w$ dBm

SNR $= -135.4 - (-158.4);$

i.e., SNR = 23 dB..(5)

So, reducing the feedline loss by 1 dB has resulted in an increased signal-to-noise ratio of approximately 3 dB which can in itself make a significant improvement in signal quality.

To illustrate the point of path loss, if say 1,000 watts were to be aimed at the moon (on 70 cm) with a unity gain antenna and no feedline losses, one could expect energy equivalent to $(1{,}000/10^{25})$ watts to be received back on earth and this energy would be spread over the earth's surface (i.e., hemispherical). If all this energy could be picked up by a unity gain antenna, the voltage across the receiver input terminals (impedance 50 ohms) would be 7.7×10^{-5} microvolts. This obviously is a very small voltage. Therefore, it becomes important to increase the transmitter output power and the antenna's gain to the point where there is sufficient energy received back on earth from the moon which will cause a minimum increase of approximately 8 dB above a cold sky reference and to end up with a signal-to-noise ratio of 4 dB or greater.

Propagation

What is libration fading and what is Faraday Rotation? Possibly the simplest way to describe libration fading is to consider the moon's surface, which is a very poor reflecting medium, to be covered in tiny mirrors placed at random angles all over its surface. When illuminated by radio waves, reflections occur and due to the movement of the moon's axis; i.e., its libration, very tiny movements of these mirrors cause in-phase and out-of-phase components to mix in the reflected radiowaves, which ultimately reach the earth very badly scattered, sometimes increasing and sometimes decreasing in intensity. The net result of this scattering process is to round off, in the case of radiowaves, any square shaped pulses and furthermore, the cancellation of waves tends to take out whole "dots" and made "dashes" sound like peculiar "dots." This can be very serious and confusing, particularly when a marginal station is trying to communicate. Large gaps occur during reception of a signal and additionally the peaks of the signal pulses become accentuated due to "in phase" components, so an operator suddenly hears a burst of pulses, which more often than not, is quite impossible to decode. The only solution is to increase transmitter power, or antenna gain at one or both ends of the link since it is impossible to correct the libration itself. At two meters the fades are relatively slow, at 70 cm they can occur at about three times a second and at 23 cm they have been measured at nine times a second; i.e., there are as many as nine fades per second or nine enhancements per second and they occur at random.

The Faraday Rotation affects the angle between the plane of polarization and the incident wave and the antenna. In effect, ionospheric rotation of the plane of polarization occurs, in the presence of the earth's magnetic field, when an electromagnetic wave passes through the ionosphere. Since it has to do this twice, on the upward and the downward journey, the plane of polarization striking the receiving antenna can be as much as 90 degrees out of phase. Since the voltage generated in an antenna is proportional to the cosine of this angle, a 90-degree rotation will result in no signals being heard at all! The degree of angular rotation varies considerably and is dependent on the ultra-violet rays striking the ionized layers. At night, for example, at 432 MHz rotation of the plane of polarization may be as little as 10 or 20 degrees, but at sunrise; i.e., when sunlight may be striking that part of the ionosphere through which the EME wave is to pass, it has been found that the angular rotation can change quite rapidly and has often been observed to be at or near 90 degrees resulting in a "no-signal" condition.

Fortunately, Faraday Rotation can be totally nullified by using a circularly-polarized antenna. However, libration fading will remain even under these conditions and some loss of intelligibility is inevitable, hence the need for repeating words and numbers at least two or three times.

The Antenna

This is the biggest and often the most expensive part of the station. For ideal operation it should be sited such that it can see all the way down to the horizon (in the Northern Hemisphere from East through South to West and in the Southern Hemisphere from East through North to West). Trees and houses are a distinct disadvantage since they cause moon blockage, loss of signal, echoes and they increase the background noise in the receiver system.

There are commercially made Yagis which a number of experimenters have built up into multi-Yagi arrays. However, most experimenters prefer to build their own and, although it is very time consuming, it may be less costly. Surplus parabolic reflectors come onto the market from time to time and these are usually gathered up very quickly and built into full antenna systems. The design and construction of a big parabolic dish antenna is a very ambitious task. It has been done, but requires an enormous amount of patience and engineering ability since it is not always realized how important the effects of the structural stresses and strains in a large reflector are. Some experimenters have built a parabolic dish antenna very quickly by employing the "stressed skin" method. The antenna structure looks somewhat like a large umbrella and, after pulling the ends of the trusses in toward the center, the antenna takes the shape of a paraboloid. A lightweight reflecting surface is then applied. There is, however, a maximum overall size which may be practical: about 20 feet in diameter.

The antenna should be remotely controlled; semi-automatic tracking should be built in so that one does not have to depend on a visible moon. More often than not the moon is not visible because of cloud cover or it may be in its darkest phase at Perigee. Too many experimenters seem to trust luck when tracking the moon and for this reason they often fail.

Since there is a strong possibility that radiation hazards could occur if people in nearby houses are subjected to large doses of radiation, it is very important to set a definite elevation limit in these directions such that the antenna's main lobe will not do any harm.

Guidance

This is so important that it deserves a separate paragraph. EME often occurs under cold/inclement weather conditions and so it is advisable to build a reliable guidance system which can be depended upon to work even in the worst weather. The antenna gain is related to the beam width of the main lobe to its half power points. While a two degree error in pointing accuracy may be quite acceptable at 2 meters, it is likely to be marginal at 70 cm and could spell failure altogether at 23 cm.

The most popular form of guidance is the Selsyn type of synchro with its repeaters. A good system will yield a ± degree error tolerance with a 1:1 gear ration between the synchro and the antenna drive shafts. Of course, by means of gearing it is possible to install a 20:1 or 30:1 ratio thereby greatly increasing pointing accuracy, but such devices present a maintenance problem. By far the best system is the digital/electronic which can be designed to give less than one degree pointing accuracy with the minimum amount of moving parts. A distinct advantage of this system is that it can be changed to provide automatic tracking of the antenna. The construction of a digital system is, in itself, quite a big engineering challenge.

The choice of antenna mounts; polar or equatorial or Alt/AZ will naturally dictate in what form the guidance figures are to be printed by computer. Since the Nautical Almanac only provides Greenwich hour angle and declination figures hourly for the moon, it is necessary to interpolate between these limits to obtain pointing angles at 2½ or 5-minute intervals as required.

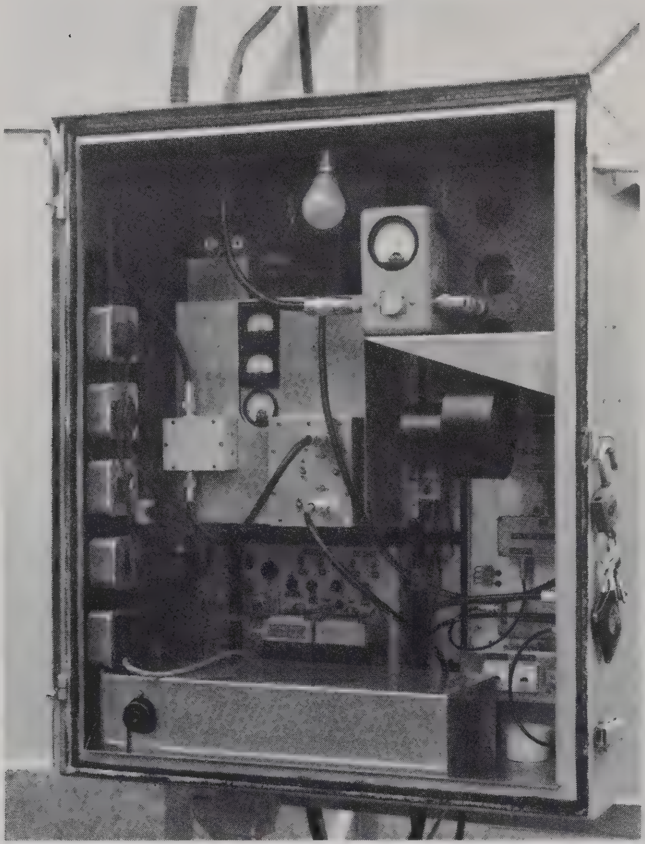
Whatever system is adopted, my adivse to anyone contemplating EME is simply *DON'T depend on a visible moon*. It is not satisfactory.

Receiving System

The old saying, "if you can't hear them, you won't work them" still holds on EME, probably more so than ever. The EME receiver has to be supersensitive, otherwise the whole exercise is wasted. Very, very low-noise amplifiers are a "must."

Good quality coaxial relays with adequate interlock protection and high isolation should always be used since very low-noise devices are easily damaged by rf burnout and spikes. Converters from carrier frequency down to an i-f of 28 MHz compatible with a good quality communications receiver are now readily available, but one should be exceedingly careful to obtain one with good frequency stability. Stability within ± 1 kHz at the carrier frequency is essential, and one should keep in mind that as the carrier frequency goes up, so does the Doppler shift resulting from the moon's movement in its orbit around the earth which is greatest at sunrise and sunset and amounts to about 1.2 MHz maximum at 70 cm.

A reliable and accurate method of checking carrier frequency calibration is most important since stations are expected to be within ± 1 kHz of an appointed frequency discounting the Doppler shift. This may be done quite simply by comparing a reference oscillator with WWV and counting the beats or possibly by using a stable frequency counter. The overall receiving system must be able to respond to very weak echoes and so the understanding, treatment and application of low-noise techniques to solid-state preamplifiers is mandatory. A system which is able to hear sky noise at an antenna temperature of 30 degrees Kelvin is in much better shape to receive weak echoes than one at 200 degrees Kelvin. In the latter case, the inherent noise within the receiving station will completely mask weak echoes of the order of 50 degrees Kelvin and more and only signals in excess of 200 degrees Kelvin would be heard. After detection has taken place, the raw af signal should be processed. It should be passed through a narrow band filter of the order of 100 Hz. The active audio filters, of which a number are available commercially, are quite suitable. A filter of this type will do much to enhance and clear up the audio signal resulting from echoes.



Equipment cabinet at the base of the tower. This setup is for 432 MHz and is almost entirely homebuilt by the author.

Transmitting System

Some means of generating a carrier at output frequency must be found. One popular method is to use an up-converter and an hf transceiver on 28 MHz, thereafter a series of linear amplifiers are required to boost the signal, be it cw or ssb, sufficiently to drive the final amplifier to a full kilowatt input. The other method is to generate a two-meter signal from a VXO controlled source, then by tripling it one can eventually obtain sufficient drive for a final amplifier in Class C. Under these conditions, there is no point in changing amplifiers to linear operation and one is limited to only cw. One area which is important is the purity of the transmitter output. It is essential that great efforts should be made to achieve a clean, chirp-free, harmonic-free signal.

I cannot stress too strongly the great importance of positive coaxial relay switching. VOX operation has been attempted by some stations I know of with disastrous results; burn out of GaAsfet preamplifiers. Don't employ VOX control. The reason for saying this is that when de-energizing relay coils, there is a finite time delay and if the rf has not been cut off, there is a grave possibility that a spike will get through and burn out the GaAsfet preamplifier.

Generally there is a need to reduce losses which become considerable at 70 cm and above. Therefore, it has been a long-established practice to install preamplifiers as close as possible to the antenna feed point. Each connector and every inch of coax ahead of a sensitive preamplifier adds to the loss, and whether you regard this as dB or noise temperature in degrees Kelvin, it degrades the first preamplifier and its superb ability to hear very very weak echoes is nullified. From a practical point of view, it is often difficult to mount a big final amplifier at the antenna terminals, in this case, it is usual to site the amplifier a short distance away in a waterproof, weatherproof box and feed the power to the antenna via low-loss coaxial cable; preferably of the Heliax type. Inevitably there is some loss, particularly where flexible cable is necessary, but so long as this is kept to 1 dB or less, it can be easily compensated for by increasing the transmitter output power slightly.

Types of Equipment Available Commercially

For the receiving system, a range of converters are available worldwide which are considered good value. These are made by Microwave Modules in the United Kingdom.* Converters for two meters, 70 cm and 23 cm are remarkably small, inexpensive and surprisingly the oscillator injection is stable enough for EME. Low-noise preamplifiers are available, but these are quite expensive and most experimenters prefer to build their own. Apart from saving money the preamplifiers are generally quite easy to build and the experimenter begins to get a feel for low-noise techniques and how to optimize his system for best noise figure. A stable communications receiver is, of course, necessary and there are many types in use on EME. Possibly the one requirement which is very important is the ability for a receiver to go to 500-Hz i-f bandwidth or less. The improvement in S/N ratio resulting is remarkable. Audio filters of an active type are usually necessary to reduce the bandwidth down to the order of 100 Hz. The transmitting system is perhaps not so exacting, but nevertheless, it is very important. In this area rf generation is often achieved by using an hf transceiver at 28 MHz and feeding this rf into an up-converter. Microwave Modules makes an excellent 10-watt output transverter, which can drive a linear amplifier to full output. On two meters, the K2RIW two-tube amplifier is very popular. The same type of amplifier may be built for 70 cm using either 4CX250B or 4CX350B tubes enabling a kilowatt of rf to be generated. These amplifiers, however, are not available commercially and, therefore, have to be built. On 23 cm a very popular amplifier is the UPX-4 modified, thanks to the expertise of Dick Turrin, W2IMU. This consists of six 2C39 tubes in a ring formation. This system will run a kilowatt input and generates rf output of about 500 to 600 watts. Of course a fairly large driver is required for the UPX-4 and it is usual to employ a two-tube (2C39) driver. A typical layout is advertised in the ARRL *VHF Handbook* by W6ION and a new design has just been built by OZ9CR, who also builds UPX-4 type amplifiers as kits for sale.

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*And advertised in *ORBIT* Magazine

Rear view of the 32-foot diameter dish showing structural details

Antenna Feeds

Regarding antenna feeds for those who have parabolic dishes, a word of caution. Before deciding on a particular type of feed, be certain to investigate the f/D ratio of the dish and select a feed which has been proved for that ratio, or you may find yourself in a situation where inefficient surface illumination occurs. For f/D ratios of 0.5/0.6 the W2IMU horn for 1296 MHz and K3BPP EIA feed for 432 MHz are excellent. Some experimenters use switchable dipoles on 70 cm and many prefer rotatable linear feeds. A new feed (to EME) for 70 and 23 cm is under development by VK2ALU. This is a very efficient "disc" type which is small and can be built into a two-band feed. However, a hybrid is necessary for the dish feed in order to achieve circular polarization. In the case of the W2IMU horn feed, this is unnecessary since a modification can be applied which effectively polarizes the feed.

After EME, What's Next?

Radio Astronomy, of course. Here one listens to the noises from outer space and learns a great deal about astronomy and about the strange radiations that emanate from sources millions of light years far out beyond our solar system. Clearly this is a subject of its own. Suffice it to say, however, that a good EME station is the basic tool for Radio Astronomy, but to make it effective, it must be modified to some extent to be able to use it for long periods on drift scans, etc. Some form of chart recorder is, of course, necessary, which is backed up with an accurate time logging system. Scientific events have little significance if they cannot be related in time and hence position in space.

Comets

There once was a Ham from D.C.
With T-Shirts he went on T.V.
"For a ten-buck donation
You'll be a sensation
And AMSAT can build you Phase III."

This limerick was used to generate interest in AMSAT's new promotional device, T-shirts. First introduced at the Dayton Hamfest, these blue background T-shirts are perfect for you to promote your favorite phase of Amateur Radio: the Satellite Program. Ideal for conventions and Hamfests. Send your $10 donation to "T-Shirts," AMSAT Headquarters, P.O. Box 27, Washington, DC 20044, and help build the next generation of Amateur Radio Satellites!

Helical Antenna Construction for 146 MHZ

By Dick Jansson,* WD4FAB

The successes of operating OSCAR 8 Mode J on 435 MHz by W7US, and others, is to a large part credited to the circularly polarized Helical antenna. Circular Polarization as a way of life is not solely due to circular polarized emissions from the satellite but predominantly a function of spacecraft spin and tumble motions. These motions create polarization shifts in the signal path with attendant peaks and nulls. The Helix goes a long way to eliminating the effects of polarization shifts.

In an effort to capitalize on the fine performance of the 435 MHz Helix, Fig. 1, the 146 MHz Helix was constructed as shown in Fig. 2. While this article is not intended to provide detailed construction information, it is hoped to present enough information to allow duplication by the more experienced builder. I must, however, severely limit my liabilities on the design since only one unit has been built to date. While the structure is strong it has not been tested under icing conditions (a rare phenomena in central Florida). As in past efforts[1] reliance is placed on photo illustration techniques to highlight the details of antenna construction.

The key dimensions of the Helix are listed in Table I. These dimensions are not critical, as the antenna is a broadband device, and are similar to those seen in numerous references in the amateur and professional literature[2].

Fundamental to this Helical antenna design is the construction of a large but very light and strong truss beam. Dimensions of the truss are shown in Fig. 3. Basic construction methods employ redwood and fir trim strip stock with ¼-inch-square spruce strip wood from the model airplane hobby store. These wooden members are joined with cleats, brass wood screws, and resorcinal resin waterproof glue, Fig. 4. Weather resistance and protection is desired and the selection of joining materials should impart longevity. The wood is further protected with a coat of shellac and then with a plastic finish intended for marine use employing sun shielding agents.

An aluminum angle or 'U' channel 'backbone' is used to capture the wooden truss through the ends of the top and bottom longerons (and end cleats). This aluminum structure also provides a mounting for the 15-inch-square reflector plate and the elevation axis spar, Fig. 7. All screw hardware associated with the backbone and reflector is of stainless steel to insure corrosion resistance.

A 32-spoke reflector plane is made of 1/8-inch-diameter aluminum welding rods attached with formed eyes and aluminum clips to the reflector plate, Fig. 7 and 8. Only 31 wires are used because the elevation axis tube serves for the 32nd. There is no magic as to the number of wires in the reflector. Following the precepts of W2FMI and others, the more ground plane, the better, and 32 seemed convenient with the pattern shown. After attachment, the reflector radius was measured and wires trimmed to length.

Partially shown in the illustrations is a simple aluminum triangular counterweight bracket of ½-inch angle located behind the reflector. The maximum projection here is 46 inches, needed to clear the roof of the house. Only five pounds of lead were needed on this bracket to counterbalance the entire antenna. With the counterbalancing as shown, the use of an Alliance U100 TV rotor for the elevation axis is quite feasible.

Creating the Helix for the antenna involves the use of cardboard circular template of the inside diameter of the flat coil. A 50-foot coil of copper tubing was maneuvered and manipulated to the desired size and circular shape. Use of new tubing will avoid unwanted

*1130 Willowbrook Trail, Maitland, FL 32751

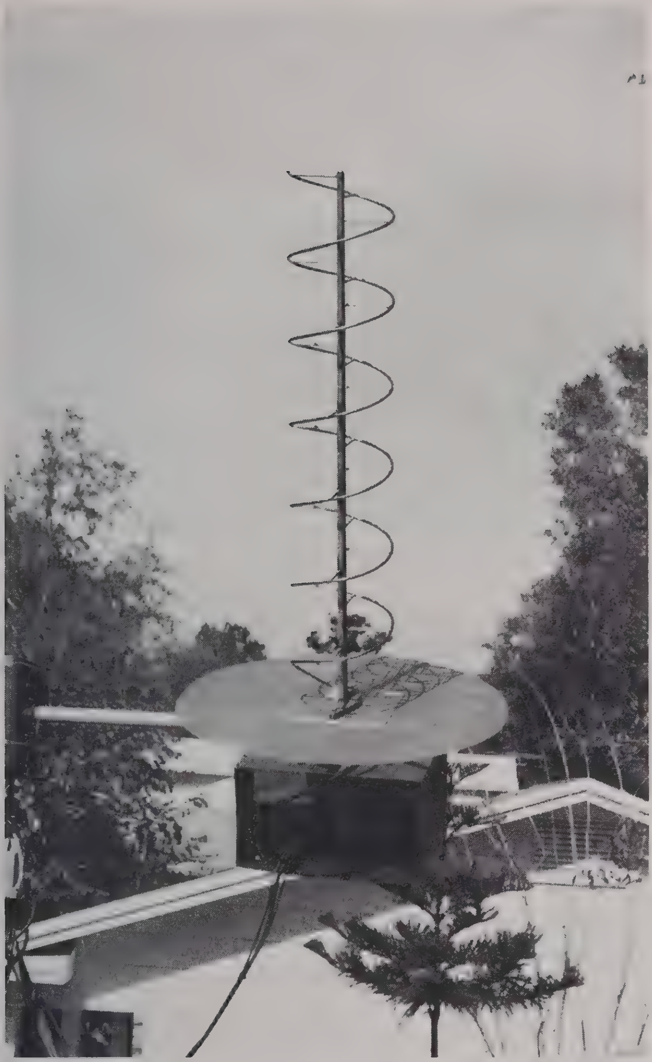


Fig. 1 — The 435-MHz Helical antenna mounted in position.

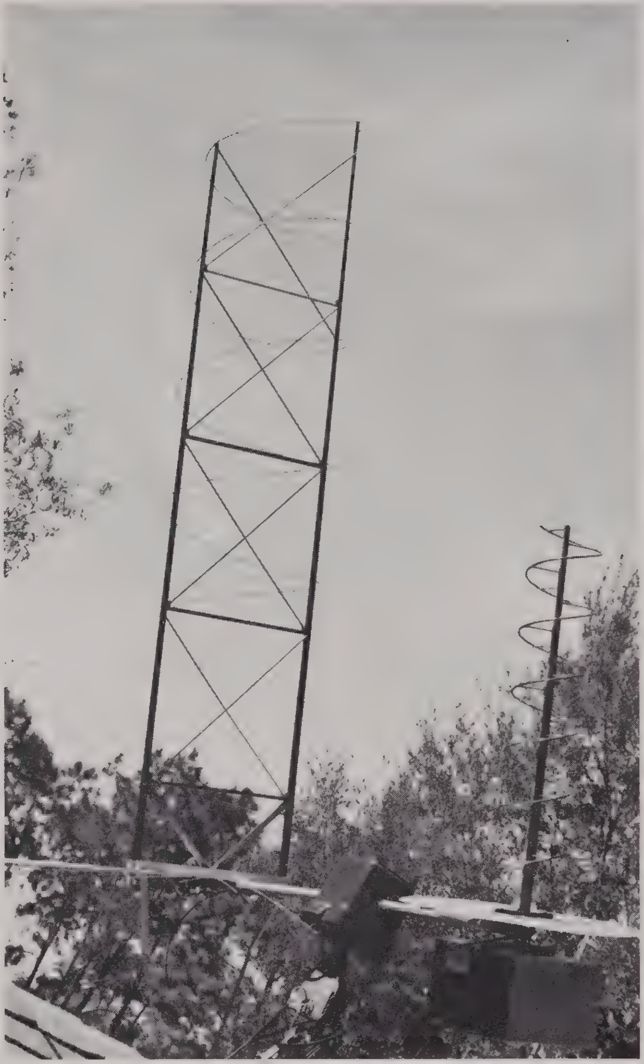


Fig. 2 — The 146-MHz antenna is quite a bit larger!

Table I — Key Dimensions for the two-meter Helix antenna.

Number of turns: 6
Nominal gain: 10 dB
Length per turn: 1 wavelength, 80.9 inches
Pitch spacing: 0.228 wavelength, 18.45 inches
First attachment point: 9.25 inches
Mean dia. of flat coil: 25.75 inches
Reflector dia.: 0.8 wavelength, 64 inches

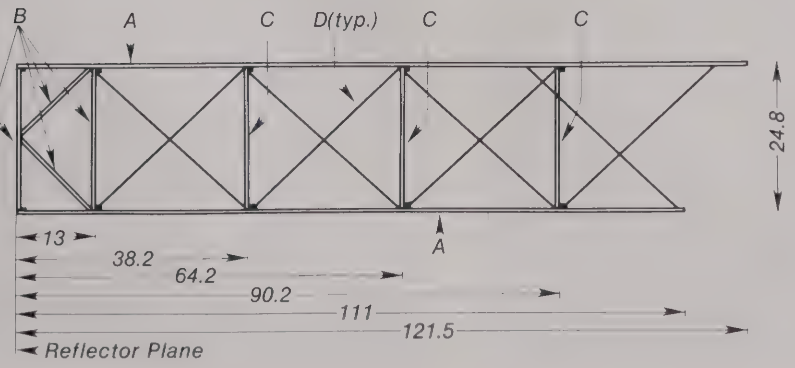


Fig. 3 — Details for the 146-MHz Helical antenna main truss. (A) Redwood or Fir, 2½ X 7/16 inches, tapered starting at 13 inches to ½-inch wide at the tip. (B) Fir, 2½ X 7/16 inches. (C) Fir, ½ X ½ inch. (D) Spruce, ¼ X ¼ X 36 inches, Stripwood.

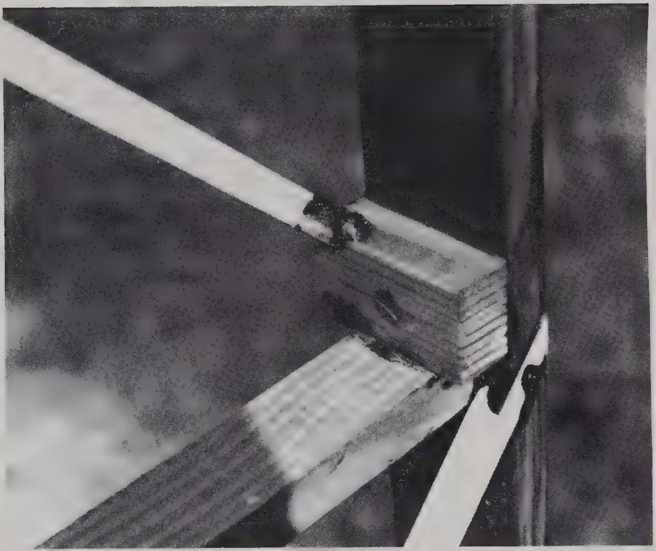


Fig. 4 — Cleated truss joint showing insetted and glued ¼ X ¼ inch diagonal braces. Pin brace with round wooden toothpick.

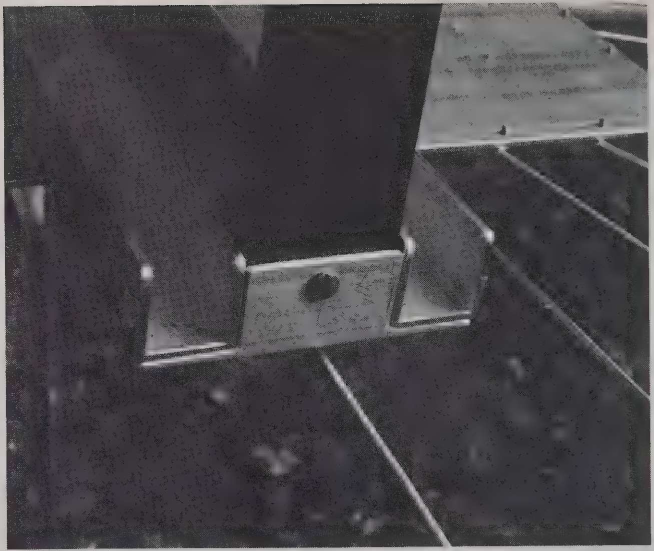


Fig. 5 — Junction of truss top rail and aluminum backbone.

kinks and ripples. An ink mark was placed at each one-half turn of coil (180°), locating the attachment to the truss position. As the Helix turns are formed, the adjacent turns were taped together to assist in holding the coil shape. Careful work on the soft copper using only the bare hands is quite adequate to form the coil.

One of the 'if-I-had-to-do-it-again' points is that a 1/8-inch diameter copper tube was used for the element and a ¼-inch tube would be preferable for holding the coil shape. The smaller tubing holds its shape on the antenna only a little better than a wet noodle would.

Attachment of the Helix to the truss is by means of small copper 'U' clips around the element at each point and held down with a brass wood screw, Fig. 9. It will be noted that this Helix is wound right hand circularly polarized (RHCP). In the hours just before the launch of the Phase IIIA spacecraft, the element was removed and relocated as left hand circularly polarized (LHCP), the whole task taking less than an hour. Tests with OSCAR 8 in both the Right Hand and Left Hand modes were not heavily conclusive but favored the right hand formation. After May 23, 1980, the element was returned to RHCP configuration.

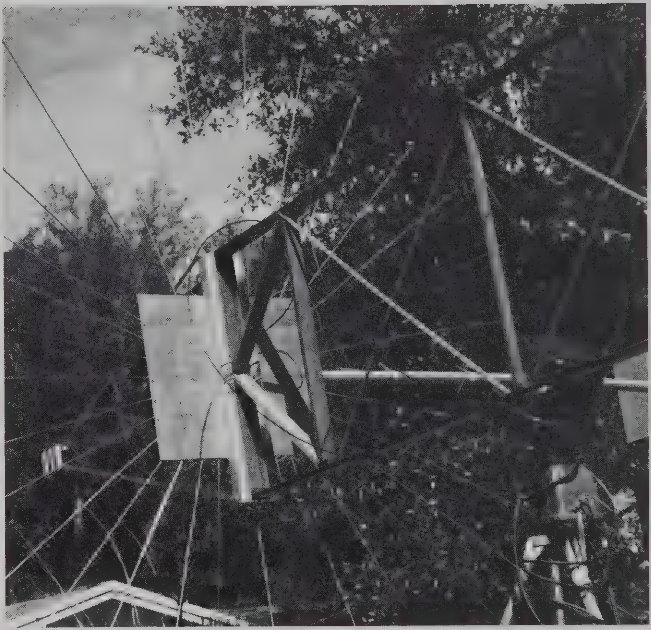


Fig. 8 — The 146-MHz Helical antenna reflector assembly.

Fig. 6 — Backbone, truss diagonals, and reflector plane.

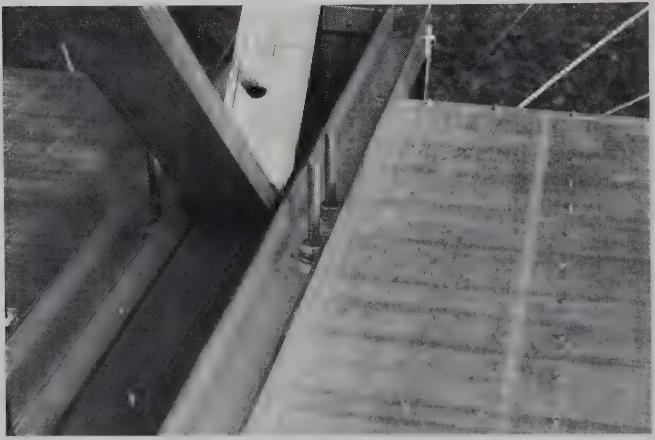
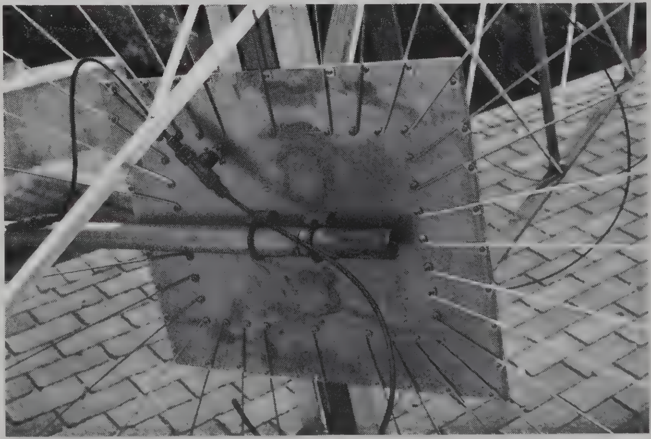


Fig. 7 — Rear view of reflector plane with radial wires and elevation axis tube.



Feedline matching techniques have been evolved for both the 435 and 144 MHz Helical antennas. These methods will be illustrated in a future article. The techniques are easy, tunable, and give very flat matching. Meanwhile, get out the saws, screwdriver, and glue pot and go to it.

References

1. Jansson, Dick, WD4FAB, '70-cm Satellite Antenna Techniques,' *ORBIT* Magazine, March 1980.
2. *RSGB VHF Handbook.*

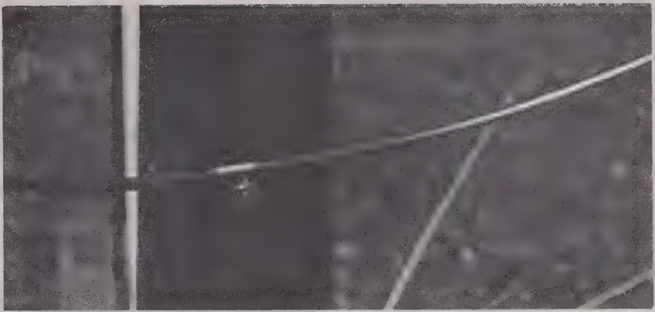
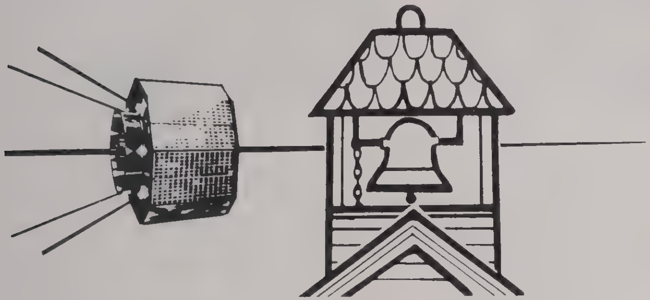


Fig. 9 — The helix element is attached to the truss rail as shown above.



OSCAR In The Classroom

By Mark J. Wilson,*AA2Z

Although most of the AMSAT membership has probably heard of the OSCAR Education Program, many *ORBIT* readers may not know what it is or how it works. This first column gives some background information on the program and outlines the steps ARRL is currently taking to implement it. The next column will explain how *you* can get involved.

What is the OSCAR Education Program?

The OSCAR Education Program is an educational program of interest to educators teaching space science, physics, mathematics and electronics. Sponsored by the ARRL in conjunction with AMSAT, it is available free of charge to educators expressing an interest. So far, about 4,000 educators in the United States and abroad have used the program in their classrooms.

The program is designed to introduce students to modern space science technology and Amateur Radio using amateur spacecraft. The OSCAR series is an ideal tool for classroom use because it provides students with an opportunity otherwise unavailable — direct access to an actual communications satellite. OSCAR is a remote (outside the classroom) laboratory tool available for use by students the world over. The satellites are especially useful for providing actual demonstrations of normally unfamiliar concepts such as Doppler. (Even though you encounter Doppler on every pass, most people have never heard it.)

Current ARRL Activities

Most of the current OSCAR Education activity is devoted to getting information into the hands of educators interested in the program. We send an educator's kit to all teachers sending a request on their school letterhead. This kit includes copies of the *Space Science Involvement* curriculum guide; OSCAR-LOCATOR maps, overlays and directions; telemetry information including a reprint of the *QST* article "OSCAR 8 Has a Message for You," and the pamphlet "Learning Morse Code Numbers"; the *OSCAR For Beginners* leaflet; and copies of the *OSCAR in the Classroom* newsletter. With this information, educators know enough to teach their classes about satellites and to listen to OSCAR if they care to.

The curriculum guide *Space Science Involvement* is currently undergoing revision. This book is the mainstay of the program, and it contains information on satellite fundamentals, tracking, orbital mechanics, telemetry and Doppler. The book also contains sections on scientific and mathematical activities involving OSCAR. The new edition will contain updated information on AMSAT-OSCAR's 7, 8 and Phase III. Sections on AMSAT-OSCAR 8 telemetry and new telemetry uses, using computers to track OSCAR, power budgets and satellite systems, and practical information on setting up a station are also planned.

To keep in touch with educators using the program, we publish the *OSCAR in the Classroom* newsletter five times each school year. The newsletter keeps educators up-to-date with current satellite news, provides a vehicle for educators to share ideas with each other and provides recognition of educators' efforts. The newsletter is sent to 3,600 educators in the United States and about 600 abroad.

In our attempts to reach the education community with information, ARRL attended the National Science Teachers Association annual convention in April. Many science teachers attending the convention expressed an interest in the program. In addition, we are renewing contacts with the education community through educational magazines such as the National Air and Space Museum's *Air and Space* and other publications.

Future Activities

The successful launch of UoSAT and Phase III-B will have direct benefits for the OSCAR Education Program as well as the amateur community. UoSAT is billed as an educational satellite and, as such, will not carry a communications transponder. Instead, it will carry beacons operating on a number of amateur frequencies and several educational projects. The proposed earth-facing camera and speech telemetry experiments are of particular interest to educators.

Phase III and the educational special service channel will have a major impact on the educational program. Because of the extended range and access times, students will be able to use the satellite as a tool for study as well as an object of study. They will be able to hold on-the-air discussions with other students (observing third-party agreements, of course), learning first-hand about other cultures. Language students will have the rare opportunity to talk with people from the country which they are studying, and many educational bulletins and lectures on a variety of topics are also planned.

In an effort to equip educators with a low-cost yet effective means of receiving Mode-A satellite signals, ARRL has developed a direct conversion receiver which can be built for around $50. The receiver, which is built on a single printed-circuit board, covers from a little below 29.400 MHz to a little above 29.500 MHz. Eventually we will have several of these receivers available for loan to educators using the program and will encourage classes to build their own.

**OSCAR Education Program Manager, ARRL*

A HISTORY OF RADIO AMATEURS IN SPACE —*Part 3*

Coming of Age

By James Eagleson, WB6JNN*

I am not much over the age of thirty yet I clearly remember how we all got pretty excited not too many years ago over a few weak "beep...beeps" from a Soviet spacecraft orbiting only a few hundred miles above our heads. Indeed, some were more than pretty excited when they began to consider all the implications of that first space flight!

Sputnik, Explorer, Vanguard, Jupiter-C...these are all names that I remember well but they are now vague, book-learned names to a generation of high school students who weren't yet born during that time. Those names certainly don't envoke the fascination for today's teens that they did when many of us stood shivering in the pre-dawn darkness just for a glimpse of a sparkling satellite streaking across the sky in the 1950's.

Yet for all this, I was strangely less than excited not too long ago when I stood less than two miles from a real spaceship waiting for the launch of AMSAT-OSCAR 8. The main satellite would be dubbed Landsat 3 upon achieving orbit. Tucked away in the final rocket stage was a plasma experiment. Balancing out the entourage (literally) was AMSAT-OSCAR 8, our Amateur built communications satellite assembled in Germany, Japan, and the United States.

From two miles distance in the obscurity of a bothersome Pacific Coast storm, the launch vehicle looked unimpressive. Obviously it was too small to launch anything into earth orbit. Occasional bursts of sunlight provided flashes of its actual size, but I still had trouble relating its appearance with something powerful enough to lift such a payload into space.

The surrounding clouds brought to mind the briefing we had been given the previous evening: The good news, we were told, is that this storm is not severe enough to scrub the launch. The bad news, however, is that the city has let some water out of their reservior and the telemetry building down near the river may get flooded!

Could it be possible? Could all the high technology, financing and the fact that it never rains very hard in Southern California be reduced to scientists and technicians slinging sandbags and putting equipment on stilts to avoid scrubbing this launch? We make equipment that can operate from 10-million miles away in space but here a mere coastal storm not even strong enough to upset the delicate balance of the rocket in flight was causing a possible delay!

It didn't flood. Now we stood awaiting the final countdown. "Fifteen minutes and holding..." A built-in hold stopped the sequence for a brief time. We surveyed the scene finding just a glimmer of light in the direction of the wind. We all siezed on the hope that this small break in the clouds might just pass over the launch site at the right moment so that we could see more than three or four rocket lengths at take off before the vehicle would disappear into the clouds. It was a rotten day for this, really!

"Five minutes and counting..." We see the clouds begin to part rapidly becoming sky-to-sky blue; perfect visibility from horizon to horizon.

"Five, four, three, two, one... we have ignition." We begin to see light dancing all around the vehicle, then sunlike brilliance as the rocket clears the pad doing an uneasy little "S" curve as the gyros stabilize its path.

**Technical Director, Project OSCAR*

Then the explosive roar hits our ears and bodies leaving no doubt that, indeed, this rocket can put that load into space. About one-half mile in the air, it tilts about 30 degrees away from the populated California coast and rushes away over the Pacific. It will shortly find a new home some 500 miles above our heads.

No one really knows how long we stood there looking up at the smokey exhaust trail until it looked like nothing more than the contrail of a high-flying jetliner. Those who were new at the game shared a few anxious moments when the trail disappeared but recovered their composure when they realized that the rocket staging was about to take place with a burst and a new trail.

Finally, we reluctantly turned away toward the buses that brought us and chuckled when some wit said "Do you think you could set that one up just one more time?" We all knew what he meant.

Ten minutes later as we left the launch facility, the rain poured again. It seems funny when I think about it. Someone will indeed set that one up again. In a week, a month, or some relatively short period of time, another vehicle will leave the hard surface of the Earth behind and find a place for itself above the highest parts of our atmosphere.

Mostly, we don't think about it. Just as a passing 1972 Ford automobile doesn't impress us as we walk the streets of a busy city, spaceships have begun to join the category of the everyday. We've become used to them.

Has space travel arrived? Well, perhaps not in the Asimov, Bradbury, Clarke or Heinlein fashion, but certainly beyond the dreams of many of us just a few decades ago.

Radio Amateurs have built their eighth, ninth, tenth and eleventh satellites. The coming of age of space might be defined as a wife complaining, "Husband, you're spending too much time with that satellite."

It only gets worse Honey...it only gets worse!

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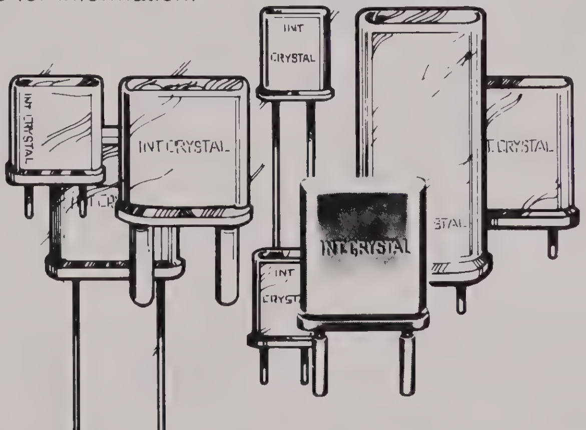

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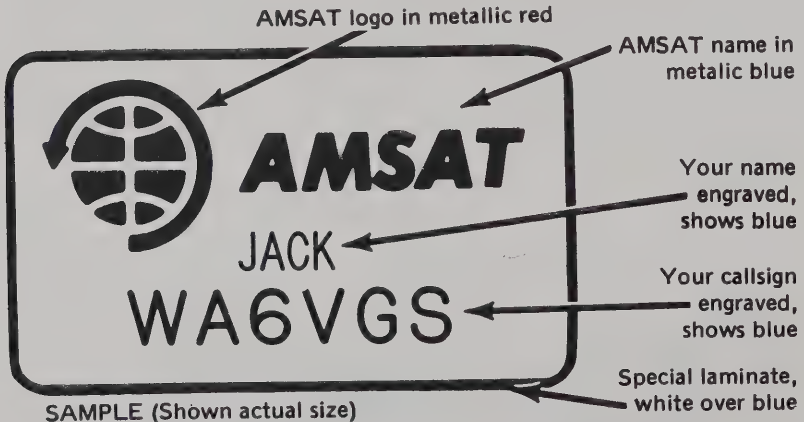
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LETTERS

Sputnik QSL Card

Dear Editor:

Readers may wonder what it says on the back of the Sputnik I QSL illustrated on page 6 of the fifth issue of *ORBIT*. The text is as follows:

"To the participating observer of the world's first Soviet artificial Earth satellite

Mr. Raphael Soifer

We thank you for the submitted report. Your observations have scientific value and will help us in processing the material related to the program of the International Geophysical Year.

We hope that we will be receiving further reports from you.

USSR Committee for IGY"

I have a similar QSL in my possession. The information on where to send the reports was printed in the *New York Times* shortly after Sputnik I was launched.

Ray's (W2RS) article on the "History of Radio Amateurs in Space - Part I" in *ORBIT* 5 brings up nostalgic memories of my first attempts to access AMSAT-OSCAR 6 back at the end of 1972. After a few days of futile efforts I finally succeeded in receiving my own downlink. Excited, and in a state of euphoria, I ran upstairs (my rig is in the basement) yelling to my XYL Sophie, "Can you imagine?! I can hear myself! I can hear myself!!" She apparently was not as impressed as I was, and commented: "I guess you surely turned full circle now. Before, you, at least, have been talking to other people. But now, you have started conversing on the radio with *yourself*."—*K2ZRO*

Black Friday

Dear Editor:

I am 73 years old. My health is still good, but after "Black Friday" and the loss of Phase IIIA I was very worried about the lost opportunity of operating via Phase III because the next launch probably would be after my death. I am now very glad and optimistic about working through Phase IIIB.

I am a Radio Engineer and worked 51 years in Broadcasting in the same company. I am now retired as of one year ago and my true hobby always was the Radio! I now have more time to devote to Amateur Radio.—*EA4AO*

Geostationary

Several exciting proposals recently have been made regarding geosynchronous radio amateur satellite projects. Tentative statements to date all suggest the use of geostationary orbits. It is suggested here that this may not be always in the best interests of Amateur Radio, and that this situation arises from a basic lack of information and debate with regard to the merits of other types of geosynchronous orbit.

(Continued on page 24)

ORBITAL PREDICTIONS

By Project OSCAR, Inc.

AO-7 Period (min/orbit) =

$$114.95367 - 4.16 \times 10^{-7} \times \text{orbit number}$$

Ang. Inc. (deg./orbit) = 28.73725°

AO-8 Period (min/orbit) =

$$103.27529 - 5.23 \times 10^{-6} \times \text{orbit number}$$

Ang. Inc. (deg./orbit) =

$$25.81907 - 1.2 \times 10^{-6} \times \text{orbit number}$$

U.T.C. DATE	-- AMSAT-OSCAR 7 -- TIME (HMM:SS)	DEG.	ORBIT NUMBER	-- AMSAT-OSCAR 8 -- TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
SAT. 1 AUG. (213)	136:37	104.8	30698	24:48	68.8	17360	J
SUN. 2 AUG. (214)	35:55	89.6	30710	29:23	70.0	17374	J
MON. 3 AUG. (215)	130:09	103.2	30723	33:58	71.2	17388	A
TUE. 4 AUG. (216)	29:26	88.0	30735	38:32	72.3	17402	A+J
WED. 5 AUG. (217)	123:40	101.6	30748	43:07	73.5	17416	X
THU. 6 AUG. (218)	22:57	86.5	30760	47:42	74.7	17430	A
FRI. 7 AUG. (219)	117:11	100.1	30773	52:16	75.9	17444	A+J
SAT. 8 AUG. (220)	16:29	84.9	30785	56:51	77.0	17458	J
SUN. 9 AUG. (221)	110:43	98.5	30798	101:25	78.2	17472	J
MON. 10 AUG. (222)	10:00	83.3	30810	106:00	79.4	17486	A
TUE. 11 AUG. (223)	104:14	96.9	30823	110:34	80.6	17500	A+J
WED. 12 AUG. (224)	3:31	81.8	30835	115:09	81.7	17514	X
THU. 13 AUG. (225)	57:45	95.3	30848	119:43	82.9	17528	A
FRI. 14 AUG. (226)	151:59	108.9	30861	124:17	84.1	17542	A+J
SAT. 15 AUG. (227)	51:16	93.8	30873	128:51	85.2	17556	J
SUN. 16 AUG. (228)	145:30	107.4	30886	133:25	86.4	17570	J
MON. 17 AUG. (229)	44:48	92.2	30898	137:59	87.6	17584	A
TUE. 18 AUG. (230)	139:01	105.8	30911	142:33	88.8	17598	A+J
WED. 19 AUG. (231)	38:19	90.6	30923	3:56	64.1	17611	X
THU. 20 AUG. (232)	132:32	104.2	30936	8:30	65.3	17625	A
FRI. 21 AUG. (233)	31:50	89.1	30948	13:04	66.5	17639	A+J
SAT. 22 AUG. (234)	126:04	102.7	30961	17:38	67.6	17653	J
SUN. 23 AUG. (235)	25:21	87.5	30973	22:11	68.8	17667	J
MON. 24 AUG. (236)	119:35	101.1	30986	26:45	70.0	17681	A
TUE. 25 AUG. (237)	18:52	85.9	30998	31:19	71.2	17695	A+J
WED. 26 AUG. (238)	113:06	99.5	31011	35:52	72.3	17709	X
THU. 27 AUG. (239)	12:23	84.4	31023	40:25	73.5	17723	A
FRI. 28 AUG. (240)	106:37	97.9	31036	44:59	74.7	17737	A+J
SAT. 29 AUG. (241)	5:54	82.8	31048	49:32	75.8	17751	J
SUN. 30 AUG. (242)	100:08	96.4	31061	54:05	77.0	17765	J
MON. 31 AUG. (243)	154:22	110.0	31074	58:38	78.2	17779	A

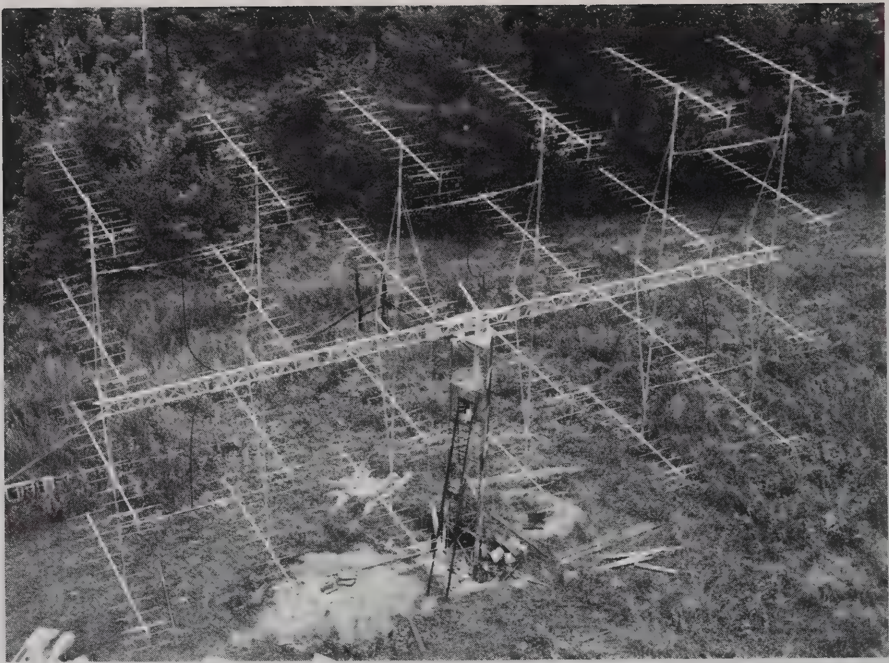
U.T.C. DATE	-- AMSAT-OSCAR 7 -- TIME (HMM:SS)	DEG.	ORBIT NUMBER	-- AMSAT-OSCAR 8 -- TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
WED. 1 JULY (182)	24:36	86.0	30309	128:36	83.9	16928	X
THU. 2 JULY (183)	118:50	99.6	30322	133:13	85.0	16942	A
FRI. 3 JULY (184)	18:07	84.4	30334	137:50	86.2	16956	A+J
SAT. 4 JULY (185)	112:21	98.0	30347	142:27	87.4	16970	J
SUN. 5 JULY (186)	11:39	82.8	30359	3:52	62.8	16983	J
MON. 6 JULY (187)	105:53	96.4	30372	8:29	64.0	16997	A
TUE. 7 JULY (188)	5:10	81.3	30384	13:05	65.2	17011	A+J
WED. 8 JULY (189)	59:24	94.8	30397	17:42	66.3	17025	X
THU. 9 JULY (190)	153:38	108.4	30410	22:18	67.5	17039	A
FRI. 10 JULY (191)	52:56	93.3	30422	26:54	68.7	17053	A+J
SAT. 11 JULY (192)	147:10	106.9	30435	31:31	69.9	17067	J
SUN. 12 JULY (193)	46:27	91.7	30447	36:07	71.1	17081	J
MON. 13 JULY (194)	140:41	105.3	30460	40:43	72.2	17095	A
TUE. 14 JULY (195)	39:59	90.1	30472	45:19	73.4	17109	A+J
WED. 15 JULY (196)	134:13	103.7	30485	49:55	74.6	17123	X
THU. 16 JULY (197)	33:30	88.6	30497	54:31	75.8	17137	A
FRI. 17 JULY (198)	127:44	102.2	30510	59:07	77.0	17151	A+J
SAT. 18 JULY (199)	27:01	87.0	30522	103:43	78.1	17165	J
SUN. 19 JULY (200)	121:15	100.6	30535	108:19	79.3	17179	J
MON. 20 JULY (201)	20:33	85.4	30547	112:55	80.5	17193	A
TUE. 21 JULY (202)	114:47	99.0	30560	117:30	81.7	17207	A+J
WED. 22 JULY (203)	14:04	83.9	30572	122:06	82.8	17221	X
THU. 23 JULY (204)	108:18	97.4	30585	126:41	84.0	17235	A
FRI. 24 JULY (205)	7:36	82.3	30597	131:17	85.2	17249	A+J
SAT. 25 JULY (206)	101:50	95.9	30610	135:52	86.4	17263	J
SUN. 26 JULY (207)	1:07	80.7	30622	140:28	87.6	17277	J
MON. 27 JULY (208)	55:21	94.3	30635	1:52	62.9	17290	A
TUE. 28 JULY (209)	149:35	107.9	30648	6:27	64.1	17304	A+J
WED. 29 JULY (210)	48:52	92.7	30660	11:02	65.3	17318	X
THU. 30 JULY (211)	143:06	106.3	30673	15:38	66.5	17332	A
FRI. 31 JULY (212)	42:24	91.2	30685	20:13	67.6	17346	A+J

U.T.C. DATE	-- AMSAT-OSCAR 7 -- TIME (HMM:SS)	DEG.	ORBIT NUMBER	-- AMSAT-OSCAR 8 -- TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
TUE. 1 SEP. (244)	53:39	94.8	31086	103:12	79.3	17793	A+J
WED. 2 SEP. (245)	147:53	108.4	31099	107:45	80.5	17807	X
THU. 3 SEP. (246)	47:10	93.2	31111	112:18	81.7	17821	A
FRI. 4 SEP. (247)	141:24	106.8	31124	116:50	82.8	17835	A+J
SAT. 5 SEP. (248)	40:41	91.7	31136	121:23	84.0	17849	J
SUN. 6 SEP. (249)	134:55	105.3	31149	125:56	85.2	17863	J
MON. 7 SEP. (250)	34:12	90.1	31161	130:29	86.3	17877	A
TUE. 8 SEP. (251)	128:26	103.7	31174	135:02	87.5	17891	A+J
WED. 9 SEP. (252)	27:43	88.5	31186	139:34	88.7	17905	X
THU. 10 SEP. (253)	121:57	102.1	31199	0:56	64.0	17918	A
FRI. 11 SEP. (254)	21:14	87.0	31211	5:28	65.2	17932	A+J
SAT. 12 SEP. (255)	115:28	100.6	31224	10:01	66.4	17946	J
SUN. 13 SEP. (256)	14:45	85.4	31236	14:33	67.5	17960	J
MON. 14 SEP. (257)	108:59	99.0	31249	19:05	68.7	17974	A
TUE. 15 SEP. (258)	8:16	83.8	31261	23:38	69.9	17988	A+J
WED. 16 SEP. (259)	102:30	97.4	31274	28:10	71.0	18002	X
THU. 17 SEP. (260)	1:47	82.3	31286	32:42	72.2	18016	A
FRI. 18 SEP. (261)	56:01	95.8	31299	37:14	73.4	18030	A+J
SAT. 19 SEP. (262)	150:15	109.4	31312	41:46	74.5	18044	J
SUN. 20 SEP. (263)	49:32	94.3	31324	46:18	75.7	18058	J
MON. 21 SEP. (264)	143:46	107.9	31337	50:50	76.9	18072	A
TUE. 22 SEP. (265)	43:03	92.7	31349	55:22	78.0	18086	A+J
WED. 23 SEP. (266)	137:16	106.3	31362	59:53	79.2	18100	X
THU. 24 SEP. (267)	36:34	91.1	31374	104:25	80.3	18114	A
FRI. 25 SEP. (268)	130:47	104.7	31387	108:57	81.5	18128	A+J
SAT. 26 SEP. (269)	30:05	89.6	31399	113:28	82.7	18142	J
SUN. 27 SEP. (270)	124:18	103.2	31412	118:00	83.8	18156	J
MON. 28 SEP. (271)	23:35	88.0	31424	122:31	85.0	18170	A
TUE. 29 SEP. (272)	117:49	101.6	31437	127:03	86.2	18184	A+J
WED. 30 SEP. (273)	17:06	86.4	31449	131:34	87.3	18198	X

E.M.E. News

(432 MHz and Above)

By Al Katz, K2UYH*



336 elements for 144 MHz at K1WHS

Activity was very high during the first contest weekend, but mother nature did not cooperate much—at best, conditions can only be rated as mixed. There was a spectacular aurora on Saturday night. This normally welcome event (VHF-wise) created real problems for northerly situated stations (and on two meters almost shut down operation).

Top honors for the first weekend again go to Jan, DL9KR with an impressive 42 QSO's in 21 sections. (Considering that Jan cannot rotate his polarization, he has to be a phenominal operator. Many reports rate Jan's signals as the strongest and most consistant heard in the contest.) Other high scores were K2UYH with 36 QSO's in 20 sections (on 432) and 2 on 1296. I5MSH with 36 QSO's in 19 sections and JA6CZD with 33 contacts in 20 sections. (Down on two meters K1WHS with his monster 24 Yagi array worked 59 stations in 21 sections.) The contest, however, is far from over and resumes again on the weekend of April 11-12. It shall be very interesting to see how the contest finally turns out.

2300 EME: PA0SSB and W6YFK completed the 1st EU/N.A. 2300 MHz EME QSO (O/M) on April 5th at 1700. During the past month, Jan made significant improvements to his system. He increased the surface accuracy of his dish, installed a new 64535 preamp (2 dB NF) and with the help of PA0DBQ upped his transmitter power to 100 watts. The final, a 7211 cavity amp, was mounted at the feed and produced consistant 2-4 dB echos. Jan is receiving 12 dB of sun noise and the ALSEP moon beacons 8 dB above the noise in a 2.1 kHz bandpass. He notes that moon tracking can be a real problem on 2304. He kept a second receiver tuned to the ALSEP frequency (2276) and used this signal to keep his antenna peaked on the moon. He reports that this arrangement works very well and that he is considering using the ALSEP signal for moon peaking even when he is operating on other bands. (Steve, W6YFK is using an 18 foot dish and 1 kW klystron amplifier.) Jan also copied Steve's 2300 ssb signals fb off the moon.

Four Yagi WAC: HB9BPQ completed the first 4 Yagi WAC (on 432) in April with contacts on the 10th with VK5MC (M/M) and the 11th with YV5ZZ (M/M)- initial #16. Keith also completed the first 432 4 Yagi to 4 Yagi QSO when he worked G3XGS on the 7th. This contact was G3XGS's initial EME QSO. Keith was not active during the 1st contest weekend and will not be able to operate again in May because of the need to remain quiet during tv viewing hours.

K4PKV: The portable 8 Yagi array appears to be working fb in N.C. Dick has now worked K2UYH, W1JR, WB5LUA, K5JL, KA0Y, I5MSH, JA6CZD, W5FF, K5FF and K3NSS. He heard during the contest JA9BOH, K9KFR, W7FU, W6ABN, N9AB and AA0F (W0PUF). He is available for skeds at any reasonable times and can be reached at (704) 634-3751. After the Yagi array moves to its next location, Dick plans to put up a 24 foot dish.

TI2NA: Eric has located the cause of his poor showing in March (He heard only ON4DY (M) at 2240 on March 14). The problem turned out to be a bad coaxial relay. His best preamp was also destroyed. During the contest he made his first EME QSO with K5JL (early on the 11th). Later a strong gust of wind damaged his dish and he was not active the rest of the weekend. Eric has since repaired the damage and will be on again in May with a new GaAsFET preamp. During EME operation, Eric is assisted by TI2WD and TI2AEB.

ZE5JJ: Peter surprised many of us by finding time to operate the contest the day before his departure for Australia. Conditions appeared good to Peter and he made 18 QSO's in 11 sections. All operation was on the 11th. He worked at 1210 VK5MC (0/M), 1248 DL9KR (0/449), 1314 JA9BOH (0/M), 1321 OK3CTP (M/0), 1331 I2COR (M/519), 1338 PA0SSB (0/0), 1348 JA6CZD (0/0), 1355 JA6AHB (M/0), 1404 G3LTF (0/0), 1416 DL7YCA (0/0), 1420 I5MSH (0/0), 1438 DJ9DL (M/0) initial QSO, 1513 SM2GGF (0/0), 1527 F6CIS (0/M), 1536 OH3TH (0/M), 1835 K9KFR (0/0), 1919 F2TU (0/0) and 2010 K2UYH (0/0). Peter will definitly be away in Australia during the May contest weekend. When he returns he plans to concentrate on 1296.

I5MSH: Piero reports that on April 10, ZS6NG was worked (M/M) for initial #99 and their 28th country. During the contest conditions were mixed. On the 11th they worked DL9KR, JA9BOH, PA0SSB, OK3CTP, JA6CZD, JA6AHB, DL7YCA, DJ9DL, ZE5JJ, I2COR, F6CIS, G3LTF, OH3TH, SM0ERR, KA1GT, F2TU, K2UYH, SM2GGF, WB5LUA, KA0Y, GW3XYW, K4PKV for initial #100 and state 25, F9FT, WB0TEM, W5FF, DL7QY, K5JL and W0PUF initial #101. On the 12th they worked W7FU, K5AZU initial #102, IW4ADT initial #105 and K9KFR. Other stations heard were HB9SV, W1XP, YU1AW, N9AB and VE1OD. I5MSH spent much of their operating time on .015. Piero notes that QRM lower in frequency was fierce and recommends that stations spread out further. The I5MSH contest team consisted of I5MSH, I5MZY, I5CTE, I5TDJ and I5UNA.

G3LTF: Peter did well in the contest, but observes that activity on 1296 was disappointingly low. On 432 (11/12th) he worked at 1320 JA6CZD, 1340 JA9BOH, 1346 DL9KR, 1353 DL7YCA, 1408 ZE5JJ, 1420 PA0SSB, 1436 OK3CTP, 1447 JA6AHB, 1500 I5MSH, 1522 F6CIS, 1630 DJ9DL, 1755 I2COR, 1813 SM0ERR initial QSO, 1828 OH3TH initial and new country, 1930 SM2GGF, 1949 F2TU, 2030 WB5LUA, 2057 K2UYH, 2115 KA0Y, 2346 W0PUF initial, 0005 K3NSS, 0021 W7FU and 1705 F9FT. Stations on Peter's called, but "got away" list include K5JL, W7GBI, GW3XYW, SM5CPD, W1JR, W0MDL, K9KFR, WB0TEM and G3XGS. On 1296 he heard nil from VK5MC and OZ9CR during skeds, but did work on the 12th at 1345 PA0SSB, 1843 LX1DB and 2210 K2UYH.

DL7QY: Claus did quite well with his 4 Yagi array in the contest. He worked on the 11/12th K2UYH (0/0), DL7YCA (M/M), I5MSH (449/449), DL9KR (M/M), KA0Y (0/0) and F2TU (0/0). He also heard

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*Dept. of Eng. Tech., Trenton State College, Trenton. NJ 08625

OK3CTP, I2COR, W1JR, DJ9DL and K3NSS. Claus reports that his address in the *Callbook* is incorrect and should read, Claus Neie, D-7181 Rudolfsberg 24, Fed. Rep. Germany.

SM0ERR: Using his old 128 el colinear array, Mart worked on the 11th at 1810 G3LTF (M/M), 1830 I5MSH (0/0), 1900 DL9KR (0/0) and 2030 K2UYH (0/0). After 2100 all signal disappeared, probably because of the aurora. On the 12th he worked F2TU (0/0). Mart is working on a 9.5 meter dish and reports that SM5BFK may be able to visit the N.E. VHF Conference in May.

DL9KR: EME-wise things have gone well for Jan during the past month. On March 15th he worked ZS6NG for the first ZS/DL QSO on 432 (M/0). In the contest on the 11th he worked DL7YCA, DJ9DL, JA6CZD, I2COR, F9FT, JA9BOH, I5MSH, LX1DB, JA6AHB, JA4BLC, ZE5JJ, PA0SSB, F6CIS, G3LTF, GW3XYW, OK3CTP, K9KFR, W1JR, SM0ERR, W1XP, K2UYH, WB5LUA, SM2GGF, KA0Y, F2TU, W6ABN, W5FF, N6GN for initial #92, SM5CPD, W7GBI, W0PUF initial #93, YV5ZZ, W0MDL, K5JL, W0RAP and K3NSS. On the 12th Jan worked WB0TEM, IW4ADT initial #94, N9AB initial #95, KA1GT and DL6WU. He also had a partial with YU1TW and heard K5AZU and W7FU. Jan wites that DJ8QL was active on 1296 and that Franz will be on 1296 on May 9th (GHA 320-60). DJ4AU was not active in April, but will be operated by Franz on May 10th. Good news, DJ4AU may also be back on 2300 soon. They have a good chance of obtaining a new klystron.

F2TU: Philip reports poor propagation. During the contest he worked F6CIS (0/0), ZE5JJ (0/0), I5MSH (539/549), G3LTF (M/0), DL9KR (0/0), OK3CTP (0/0), K2UYH (0/0), F9FT (0/0), JA9BOH (0/0), SM2GGF (M/0), SM0ERR (M/M), I2COR (0/0), N9AB (0/M), KA0Y (0/0), K9KFR (0/0), WB5LUA (0/0) and DL7QY (0/0).

OH3TH: Peter is back up again, but writes that Karl, SM3AKW lost his array in a storm and is now off the air. In the contest Peter had problems from the aurora (also receiver troubles), but worked on the 11th at 1536 ZE5JJ (0/M), 1540 I5MSH (0/0), 1626 I2COR (0/0) initial and 1825 G3LTF (0/0) initial.

SM5CPD: We have not received Uno's April report. In March he had bad weather and lost the elevation control of his array during his sked with JA6CZD. He was back in operation with a good signal in the contest.

OE6AP: We only have Alois' March report. In it he confirms his QSO with us and reports that he was using his new 4 F9FT Yagi array and MGF1412 preamp. In previous months he has worked OH3TH and JA9BOH using 4X21 J beams. In the near future he will expand to 8 F9FT Yagis.

G3WDG: Charlie's group will not be operational during the contest as they have left the old 20 foot dish site. However, they report progress on constructing a 13 foot dish which they will use on 1296 and 2300 at Charlie's new QTH.

JA6CZD: Shichiro reports average conditions during the contest. On April 11 he worked K2UYH (0/0), WB0TEM (0/0) initial, W1XP (439/439), K3NSS (579/459), WB5LUA (0/0), K4PKV (0/0) initial, K9KFR (0/0), W6ABN (0/0), W0PUF (0/M) initial, VK5MC (0/0), JA9BOH (449/439), OK3CTP (0/0), JA8QQ (429/449), VK5MC (0/0), JA9BOH (449/439), F6CIS (429/539), PA0SSB (0/0), I5MSH (449/329), DJ9DL (449/449), G3LTF (449/449), I2COR (0/M) and ZE5JJ (0/0). On the 12th he QSO'd VE4MA (0/0), N9AB (549/449) initial, W5UKQ (0/0), W7GBI (439/449), JA9AHB (449/549), JA4BLC (0/M), SM2GGF (0/0), F9FT (449/439), DJ9DL (429/449), SM5CPD (0/0) initial, IW4ADT (0/0) initial, and G3XGS (M/M) initial. Back in March Shichiro QSO'd W0RAP, DJ9DL, I2COR, G3YGF initial, DL7QY initial, G4KGC initial, JA4BLC and DL6WU.

JA9BOH: Kimio worked on April 11 at 0306 K2UYH (0/0), 0326 K3NSS (559/349), 0345 WB5LUA (0/0), 0520 K9KFR (M/0), 0607 WB0TEM (0/0), 0717 W6ABN (M/M), 0733 W0PUF (0/0), 0855 JA6CZD (439/449), 0950 JA8QQ (M/M), 0953 VK5MC (M/M), 1107 I2COR (339/529), 1141 DL9KR (0/0), 1150 F6CIS (0/0), 1210 I5MSH (449/339), 1250 JA4BLC (0/0), 1317 ZE5JJ (0/0), 1332 G3LTF (0/M), 1435 DL7YCA (0/M) and 1501 OK3CTP (0/M). On the 12th he QSO'd at 0409 K2UYH (339/339) (2nd time), 0430 VE4MA (0/0), 0553 JA6AHB (0/0), 0606 K5JL (0/0), 0623 W7GBI (0/0), 1134 DL7YCA (449/339), 1150 F9FT (0/0), 1200 F2TU (0/0), and 1221 DJ9DL (0/439). Also heard were W1XP, PA0SSB and SM2GGF.

Net News: W9IP expects to be operational off the moon in May with a kW and 4 Yagis (217) 367-4457. **W8WA** has had family problems, but is making progress getting his 16 Yagis up. **WA4ZTK** in Tennessee has his amp going and has nearly completed his dish. **W1UHE** has still not received permission from the FCC to resume high power 432 operation - he is optimistic. **K5JL** worked K4PKV in five minutes, but has still not completed with KL7WE after several hours of trying. W0HHE worked K3NSS, but did not complete any of his skeds. **K9KFR** has worked 18 stations in the contest thus far. **WB4IZR** may be operational again from his sight by the May contest weekend. **W0RAP** had thunder storm and weather problems the first night and worked DL9KR the second. **WB0VYV**, Dave is coming on 432 EME. **WB0YSG**, Jim is temporarily off 432 EME. He will let everyone know when he will be back on again. **KA0Y** was hampered by bad weather the 1st night, but worked 22 stations in the contest. **W0PUF** (AA0F) is located in S.D. and worked 12 stations during the contest. **W4WD/7** is back on 144 EME, but is holding off putting up the 432 EME array until his neighbors get used to the antennas. **K5UGM** has his 20 foot dish mounted and is hearing well, but does not have his final going yet. **OK1KIR/P** is operational on 1296 with 200 watts and a 4 meter dish. **K5FF** and **W5FF** worked KA0Y and WB6NMT on 220 EME.

For Sale/Wanted: Small dish reflectors and feeds for 1296 and 2304 are available from Kungsimport, P.O. Box 10257, S-43401 Kungsbacka, Sweden. - John Petrich, W1HQJ (206) 885-4839 informs me that he is still very much interested in purchasing Yagi arrays for 144 and 432 EME.

The 24-foot diameter dish at UB5LUA

AMSAT News

Organizational items of interest to all members of the Radio Amateur Satellite Corporation

Call for Papers on Packet Radio and Computer Networking

The American Radio Relay League is sponsoring a conference on Amateur Radio Computer Networking on October 16, 1981 at the National Bureau of Standards, Gaithersburg, MD. The purpose of the conference is to explore the possibilities of an integrated amateur computer network using HF, VHF and satellite packet radio as the primary transmission means. The network would consist of Radio Amateurs in both the U.S. and Canada and would provide means of servicing the public handling third party traffic. Papers are sought on both technical and operational topics including: network structure, protocols, message handling, equipment design and selection, software, integration with the National Traffic System, interconnection with Computerized Bulletin Board Systems, and other topics. This event will be hosted by the Amateur Radio Research and Development Corp. (AMRAD) and by the Radio Amateur Satellite Corp. (AMSAT) whose annual meeting will be held on October 17 at the nearby Goddard Space Flight Center. Those wishing to present papers should send a letter of intent to Paul L. Rinaldo, W4RI, President, AMRAD, 1524 Springvale Avenue, McLean, VA 22101 before August 15, 1981.

Project OSCAR Meetings

The Southern California division of Project OSCAR met in El Segundo, California on March 7 for a briefing on the current status of new amateur radio satellite projects. Host, Col. John Browning, W6SP, was master-of-ceremonies for an agenda that included presentations by visitors 'Rip' Riportella, WA2LQQ, from AMSAT headquarters, and Bob Shutak of Grumman Aerospace Corporation. The major focus of the meeting was a progress report on Project OSCAR's role in the SYNCART project, presented by President John Pronko, W6XN, and team members John Fail, KL7GRF, Jim Eagleson, WB6JNN, and Paul Schuch, N6TX.

Rip, WA2LQQ provided a status report on Phase IIIB. There was considerable interest in the possibility that a liquid-fuel kick motor would be available to AMSAT courtesy of a company in Germany. The greater "kick" per unit weight provided by that motor could enable the Phase III satellite to be propelled into a Molniya orbit with a 63.4 deg. inclination, which unlike the orbit planned for Phase IIIA, will maintain a relatively fixed arguement of perigee and keep the apogee over the northern hemisphere for decades. Rip also pointed out that the weight saved by using the lighter motor would permit heavier radiation protection.

John, W6XN reviewed the history of SYNCART, planned by AMSAT-Canada with John Henry, VE2VQ, as project director. Originally scheduled for a ride on Space Shuttle #6 with Hughes' SYNCOM, progress slowed when SYNCOM was cancelled. About six months ago, a revitalized and expanded Project OSCAR group (see AMSAT News in *ORBIT* No. 2) offered to assist in the design and construction of SYNCART. The Canadians accepted the offer and the SYNCART project is now proceeding "full speed ahead" as the collaborative effort under the leadership of AMSAT-Canada and VE2VQ. The power stages and i-f sections will be produced by the Canadian group. Project OSCAR will be responsible for the rf stages, the on-board digital computer, and related interface circuitry. No committment for a host satellite or ride into orbit has been obtained yet, but the group hopes to have the package up by 1984.

Mr. Shutak and Grumman provided a special finale for the meeting. Two colorful films on the European Space Agency's (ESA) activities were shown; one detailing the Ariane launch vehicle and some of its planned future derivatives, while the second displayed the Kourou launch facility and its environs in French Guiana. Arianespace, a consortium of European companies that will assume business management of the launches when ESA declares Ariane operational, commissioned the films. Grumman is the U.S. Launch Services Agent for Arianespace.

A Northern California Project OSCAR meeting was held April 11, 1981 in Palo Alto. The membership re-elected W6XN to a two year term as president. John reviewed Project OSCAR's contributions to the amateur space program during the past year, emphasizing the Orbital Calendar and participation in the SYNCART project. John, W6SP provided the Phase IIIB update. In addition to the other agenda items discussed at the meeting in El Segundo a month earlier, this meeting featured a tutorial discussion on packet transmission of digital data presented by Hank Magnuski, KA6M. The presentation sparked a lively discussion about the feasibility and utility of digital date transmission via SYNCART. *—N6TE*

Southwestern Pacific Net

The AMSAT Southwestern Pacific Net, which meets Saturdays at 2200 UTC on 28,878 kHz, has become a popular and informative meeting place for OSCAR enthusiasts. The net was created in November, 1980, to improve the flow of information about satellite-related events to hams "down under." Bud Schultz, W6CG, net control, reports that it has performed that role admirably. Bud says, the net "...hits down in the VK-ZL area about 7 a.m. Sunday (local time) and that seems to suit the hams there just fine." It also seems to suit a growing group of satellite users from other countries bordering on the Pacific. A typical check-in list contains 18-20 stations each week, including regulars ZL1WN, ZL1AOX, ZL3AAD, ZL2QX, ZL1PK, VK3ACR, VK4PJ, JA1ANG, JA4KWU, JA9BOH, WH6AMX, VE1SAT, VE3AIB, VE3EFX, VE3IXT, VE5XU, W1HDX, WA2LQQ, W3IWI, W3OZ, W5VVR, W6PAJ, W6SP, W0PN, W0RPK, and W0LER.

The regular attendance of three members of AMSAT's Board of Directors and Vice-President, WA2LQQ, assures up-to-date responses to questions from the net participants. In addition, many of the Phase IIIB command stations are on the roster, and they meet with their coordinator, W1HDX, at the end of the net. Those sessions provide interesting insights into the "mechanics" of satellite control. W6CG invites anyone interested in satellite operation to participate.*—N6TE*

Phase IIIB Tests

Tests of an important Phase IIIB transponder subsystem are reaching a climactic phase as we go to press. Word from DJ4ZC's lab at the University of Marburg was that the tests on the HELAPS (High Efficiency Linear Amplifier by Parametric Synthesis) were going well and all results were favorable. Based on the tests, a determination will be made to learn if the technique employed for the U-band transponder will provide the desired performance level for the proposed L-band version. The design challenge on the L-band version is particularly stern because the band will be wide (800 kHz) and the state of the art may not, at present, be equal to the challenge. The tests on the U-band version will provide key insight to scaling to 23 cm.

Launch Vehicle Swap

The European Space Agency (ESA) has begun a series of actions designed to minimize the impact of the continuing tests on the Ariane engines. ESA has given indications that some of the payloads in the early operational launches may be swapped with others that have critical launch windows. At press time it appeared likely that Phase IIIB would be swapped from its present berth on launch L7 to either L6 or L8. Also, it appears that the launch schedule will be stretched out so that L6 will be launched in the March/April 82 frame, L7 in May/June and L8 in June/July. In any case, however, AMSAT's ride seems quite secure despite some concern expressed as regards the flux in the schedule. Officials at AMSAT explained that at this stage of a program there is always a great deal of adjusting in schedules and payloads. "It is," as W3GEY expressed it, "just the way of doing business at this stage of development and shouldn't cause concern." *—AMSAT Satellite Report*

AMSAT-OSCAR 8 Schedule

As predicted, AMSAT-OSCAR 8 has begun to cool from the high of 47°C observed last month to the mid 30's at present. Accordingly AMSAT-OSCAR 8 will no longer provide dual A/J mid-week as had been the case recently. The schedule published in *QST* will be followed though occasional deviations to dual A/J remain at the discretion of the AMSAT-OSCAR 8 control station team members. The published schedule calls for: Mode A on UTC Thursday and Monday; J on Saturday and Sunday and A/J on Friday and Tuesday. Wednesday is experiments day.

AMSAT-OSCAR 7 Codestore Success

Operations VP K1HTV reports that attempts to load codestore by control station VE3HCR have at last proved positive. Rich says that Dave (HCR) found that the upload was successful but that the clock which gates the data out for the downlink was running very slowly. In fact the data was being keyed out at only one or two wpm. At that rate it was very difficult to determine, at first, that the codestore mechanism was working. But given the clue that the clock was running slowly, the correct codestore downlink could be readily confirmed. K1HTV suggests that component aging in the astable multivibrator that clocks the data is likely the cause of the low transmission rate. On the other hand it is good news that the circuits are working at all since that may be a benchmark for comparison of the condition of other AMSAT-OSCAR 7 circuits. *—AMSAT Satellite Report*

Life Members

AMSAT gratefully acknowledges donations of $200 or more from the following new Life Members.

Carl Preston, W8WCP
Masaya Fukasawa, JR1FIG
R.J. Harkett, ZL2FY
David Fayman, W0GI
Alberto Shaio, HK3DEU
John Dolnacko, WB8IYR
Roland Crider, K9VCM
Alberto Molina, HK4DSD
Eduardo Londono, HK4BHC
Anton J. Kittler, PY2AJK

JAMSAT Mode-M Project Status Report

We have started the Mode-M project early in 1980 with JA1MWL (Y.Yonemoto) as project manager. The project was divided into four main task groups. The following are the task groups and people who are in charge of the individual tasks.

1) Front End
   JA1TUR, O. Yamamoto
   JH1BRY, S. Sando
2) Inter Stage
   JA1JHF, H. Kanawa
   JR1WYB, Y. Tsukui
3) Power Amplifier
   JA1CBL, Y. Yokota
4) Beacon, Command, etc.
   JR1SWB, M. Nakayama
   JR1FIG, M. Fukazawa

The following are the status of the individual task groups:

Front End - The front-end which includes the LNA, BandPass Filter, mixer (down to first i-f around 100 MHz) and i-f amplifier.

Also, as far as intermodulation distorion is concerned the transponder may have interference from radar such as ASSR. So, the first LNA must have a good intermodulation distortion in order to protect against the saturation of the LNA by ASSR signals.

A GaAsFET (NE21889) was chosen for this purpose. JH1BRY designed this amplifier. The input return-loss is about 7 to 8 dB around 1260 MHz.

JA1TUR is making Local OSC for the front-end and this LOSC will supply signals to both the first mixer which makes the 100 MHZ i-f and second mixer which makes the 22.5 MHz i-f.

A bandpass filter was also designed for this system which is a two section capacitor loaded coaxial filter.

Inter Stage - This stage will be very similar construction to the Mode-J transponder of AMSAT-OSCAR 8. The Mode-J transponder had a 10.7 MHz i-f stage but JA1JHF expects to use a 22.5 MHz i-f to expand the passband to at least 360 kHz instead of the current 150 kHz bandwidth.

In the Mode-J transponder, we JAMSAT, used a MOS-FET to get 1 watt PEP of output power, but this project will use a bipolar transistor to obtain 1W PEP at the inter stage output.

Right now, JA1JHF cannot get a Xtal filter with 360 kHz bandwidth, but he hopes to get a 350 kHz filter from a Japanese filter manufacturer.

Power Amplifier - As you know, this stage will be one of the most difficult sections on this project because of power consumption.

JA1CBL is considering the use of a similar method to the Phase III transponder (which is "Doherty") but has not decided as of now. He has already gotten some bipolar transistors for this application and has started the assembly of the amplifier itself.

The power amplifier will be with a two stage design working from a supply voltage of 28 volts.

The power amplifier will be with two stage design working from a supply voltage of 28 volts.

Beacon, Command, etc. - This task group is working on the design of the ASSR radar blanker, Beacon and Command RX system. The Beacon will have PSK, FSK and CW.

In the ASSR radar blanker, when the transponder receives a radar signal through the front-end, the signal is detected at 100 MHz i-f output.

The blanker gate which will be a DBM is put into somewhere prior to X'tal filter of second i-f at 22.5 MHz.

JR1SWB and JR1FIG are working on these. They have already become familiar with both PSK and FSK.

JF1DMQ is also working on the DC-DC converter for this project. He is now trying to design the best efficiency DC-DC converter for the 50 watts power amplifier which is being designed by JA1CBL.*—JH1BRY*

UoSAT

AMSAT-DL has participated in the UoSAT project, because it furnished a fine opportunity to test some concepts for the AMSAT-Phase III satellites in space.

Werner Haas, DJ5KQ, built the battery charge regulator (BCR) for UoSAT. This is an evolution of the design which AMSAT-DL had been developing for the AMSAT-OSCAR 7 and 8 spacecraft. They are still functioning perfectly after more than six years. In order to improve the charge-behavior and to increase the life-span of the battery the temperature sensors are now installed directly into the battery-box. By means of that a better adaption of the charge-voltage to the temperature is accomplished. This concept was already employed in the Phase IIIA satellite.

As second contribution for UoSAT the programming system IPS developed by Karl Meinzer, DJ4ZC, was made available by AMSAT-DL. This computer language was also primarily developed for the Phase III program. Since the on-board computer of UoSAT is very similar to the one of the Phase III satellites, it is possible to employ the German programming language IPS almost unchanged.

In the week of 19-24 January 1981, Robin Gape, G8DQX, and Chris Trayner of the UoSAT development team visited AMSAT-DL in Marburg.*—DC7AS*

King Family Portend

AMSAT's VP-Engineering W3GEY, Jan King and his lovely wife Donna became the parents of a baby girl, Nadia Marie Sunday, 8 March. Nadia Marie weighed 7 lb. 7 oz. at birth.

Other AMSAT officials made some astute observations regarding the arrival of Nadia Marie. W3IWI advises that the blessed event occurred 9 months and 5 days after Jan's return from Kourou prior to the lanuch of Phase IIIA. Hmmmm! Maybe it was something in the French Guianese water. G3ZCZ notes that daughters of AMSAT officials are good omens. Joe's daughter's were born around the times of AMSAT-OSCAR 7 and 8 launches while Perry Klein's (W3PK) daughter was born prior to the AMSAT-OSCAR 6 launch. Since all were notable successes (daughters and satellites) Joe believes Nadia Marie's birth portends good.
—AMSAT Satellite Report

Around the World

By Kaz J. Deskur, K2ZRO*

Articles about the Radio Amateur Satellite Program are being published around the world. Some of this material, which appeared in languages other than English, was never translated and thus did not reach the maximum number of interested readers. *ORBIT* provides abstracts of such articles as they appear, and provide an indication of the level of publishing activity worldwide in the field of Amateur Space activities.

The March 1981 issue of *Ham Radio* contains three articles of interest to *ORBIT* readers:

40W 23-cm Power Amplifier

The prospects of flying an L-band transponder on the future OSCARs brings up the question: How to construct an economical transmitter capable of delivering adequate power on 23-cm band?

One such solution is described by Robert S. Stein, W6NBI. In his article, the author furnishes step-by-step instructions how to adapt cavities from the military surplus AN/UPX6 IFF transmitter to deliver approximately 40W on 1.3 GHz. The cavities contain 2C39A tubes and have a gain of approximately 11 dB per stage. The author uses three cascaded stages and obtains full output with less than 100 mW of driving power. If more drive is available, two stages, or even one stage, will suffice.

It appears that 20 watts of power, supplemented by only a moderate gain antenna of 10-13 dB should be adequate (400-800 ERP) to access the satellite on-board L-band transponder .

EME Primer

An informative EME primer, written by Bill Orr, W6SAI, is a two-part article. The first installment appeared in the February issue and covered the history, early experiments, basic principles, path losses, and general equipment requirements. The second part is more detailed in how to achieve moonbounce capability, and also features a short story, "A day in the life of a moonbouncer—K1WHS."

A booklet entitled, "Almost everything you want to know about moonbounce" is available for 36¢ in stamps (to cover mailing) from William Orr, c/o EIMAC, 301 Industrial Way, San Carlos, CA 94070.

Another Calculator Program for Phase III

A program developed by Paul C. Bunnel, WA6VJR, for HP-41C (requiring one memory module and a peripheral printer) uses only 275 instructions. The program calculates, as a function of time, the azimuth and elevation of the satellite in respect to the QTH of the tracking station and also the geographical coordinates of the ground track.

The article and the appendix may be difficult to follow for those not familiar with higher mathematics, spherical geometry, and the principles of orbital flight. In practice however, owners of an HP-41C need only to store the program by following the listed program steps and enter the appropriate orbital parameters and constants; the understanding on what assumptions the algorithm was developed is not essential or necessary.

Old Converter Doubles as Counter "Prescaler"

This idea is rather obvious, but may be new to those just getting into VHF and OSCAR work writes KA4LRT. If you have an outdated VHF or UHF converter, you have the makings of a "prescaler" for your inexpensive counter that doesn't cover the VHF bands. Functioning as a frequency translator, the converter subtracts a constant number from its input frequency rather than dividing, and amplifies the signal as well. For instance, if your converter has a 144-148 MHz input and 28-32 MHz output, it subtracts 144 − 28 = 116 MHz (the mixer injection frequency). If you feed in a two-meter signal and count 30.9 MHz at the converter output, the input frequency is actually 30.9 + 116 = 146.9 MHz. He finds that a ten-inch wire at the converter input picks up enough stray two-meter energy from his 50-watt transmitter to drive an old 50-MHz counter easily.

By changing the LO crystal to give an injection frequency of 116.458 MHz, you can make a test translator. The converter will now translate your two-meter transmit signal to the same frequency as it will have in the OSCAR 8 Mode A downlink passband, neglecting Doppler shift. This setup is handy for pretuning your ten-meter receiver to your downlink frequency before a pass. The same principle can be applied to any OSCAR mode, but be sure to use the proper high-side injection frequencies for Modes B and J, and low-side for Mode A.

*Box 11, Endicott, NY 13760

LETTERS (Continued from page 19)

What is the difference between geosynchronous and geostationary orbits? Answer: In both cases the satellite has an orbital period of 24 hours, but in the geostationary case, the satellite stays where it is, fixed directly above the same spot on the equator. In the geosynchronous orbit the satellite is free to follow an ellipse around a fixed spot on the equator. The geosynchronous satellite takes 24 hours to go around this ellipse at an inclination of usually around 30° to the equator. Each day the geosynchronous satellite traces out exactly the same sub-satellite-track points at exactly the same time of day. The geostationary satellite is of course the special case of a geosychronous orbit with 0° inclination.

All stations inside the fixed footprint coverage pattern of a typical geostationary satellite will see the satellite at least 10° above their horizon. A similar satellite in geosynchronous orbit inclination of 29° will allow stations inside the center of the footprint to see the satellite all the time. Stations in the much larger outside area see the satellite at different local times. This type of orbit is already in use by the IUE International Ultraviolet Explorer satellite, albeit with different timing to suit the astronomy oriented task.

It is suggested that Radio Amateurs need to be aware of the advantages of the very flexible geosynchronous family of orbits. They cover a much wider overall footprint. More people get to use each satellite. This type of orbit does not waste 30 percent of every day hovering over a sleeping hemisphere, and it gives high-latitude stations (KL, LA, SM, OH) good coverage when a geostationary orbit gives no coverage at all.

What are the disadvantages of geosynchronous orbits of the type discussed above? First, the satellite moves. Ground stations must have tracking aerials. However, few amateurs will be able to afford to have aerials dedicated to one satellite, and the Phase III aerial with Az/E1 control should prove eminently suitable as a basis for geosynchronous tracking. Rotation rates will be slow by Phase II standards and the satellite will follow exactly the same time/track across the sky each day, so no fancy computers will be needed to follow it. One daily tracking list will be good for a long period of use. The second problem is that you have to get the satellite into this complex orbit to start with. It will probably go aloft with a main payload bound for a geostationary location. The OSCAR package then can be slowly drifted around the equator until it reaches the right point for firing a short injection burn to put it in the required inclined orbit.

Perhaps now is the time to debate the matter, fully considering the respective merits and demerits of both the geostationary and geosynchronous orbits.—*GM4IHJ*

Satellite Log

By Geoffrey Falworth*

Satellite Log features launches into orbit since the beginning of 1980. The satellite name is that assigned by the launching agency (the international designation is in parenthesis) and the orbit (period, inclination to Earth's equator, apogee height, perigee height) is for shortly after launch; later maneuvers may modify this orbit. Transmissions are those which are publicly reported or assumed from the type of spacecraft involved.

Cosmos 1223 (1980-95A) launched on 1980 Nov 27; initial orbit: 717.80 min, 62°.86, 39751 km, 606 km; transmissions: 2292 MHz. Early warning satellite.

Cosmos 1224 (1980-96A) launched on 1980 Dec 1; initial orbit: 90.29 min, 72°.87, 378 km, 198 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1225 (1980-97A) launched on 1980 Dec 5; initial orbit: 104.94 min, 82°.94, 1031 km, 950 km; transmissions 150.000 MHz. Navigation satellite.

Intelsat 5A (F2) (1980-98A) launched on 1980 Dec 6; initial orbit: 1431.20 min, 0°.81, 35736 km, 35655 km; transmissions: 3704 to 3781 MHz, 3789 to 3861 MHz, 3869 to 3941 MHz, 3947.500 MHz, 3952.500 MHz, 3959 to 4031 MHz, 4037 to 4073 MHz, 4077 to 4113 MHz, 4117 to 4153 MHz, 4157 to 4198 MHz, 10954 to 11031 MHz, 11119 to 11191 MHz, 11196.000 MHz. International telecommunications satellite for service over eastern Atlantic Ocean. Currently on test over 15° East.

Cosmos 1226 (1980-99A) launched on 1980 Dec 10; initial orbit: 104.93 min, 82°.94, 1014 km, 966 km; transmissions: 150.000 MHz. Navigation satellite.

Operations 5805 (1980-100A) launched on 1980 Dec 13; initial orbit: 697.98 min, 63°.89, 39127 km, 250 km; transmissions: none reported. Military satellite data system spacecraft.

Cosmos 1227 (1980-101A) launched on 1980 Dec 16; initial orbit: 89.50 min, 72°.85, 300 km, 199 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1228 (1980-102A) launched on 1980 Dec 23; initial orbit: 114.47 min, 73°.96, 1472 km, 1390 km; transmissions: none reported. Military communications satellite.

Cosmos 1229 (1980-102B) launched on 1980 Dec 23; initial orbit: 115.07 min, 73°.82, 1499 km, 1418 km; transmissions: none reported. Military communications satellite.

Cosmos 1230 (1980-102C) launched on 1980 Dec 23; initial orbit: 114.55 min, 74°.00, 1447 km, 1421 km; transmissions: none reported. Military communications satellite.

Cosmos 1231 (1980-102D) launched on 1980 Dec 23; initial orbit: 114.69 min, 74°.02, 1480 km, 1402 km; transmissions: none reported. Military communications satellite.

Cosmos 1232 (1980-102E) launched on 1980 Dec 23; initial orbit: 114.69 min, 74°.06, 1454 km, 1427 km; transmissions: none reported. Military communications satellite.

Cosmos 1233 (1980-102F) launched on 1980 Dec 23; initial orbit: 114.75 min, 73°.99, 1466 km, 1421 km; transmissions: none reported. Military communications satellite.

Cosmos 1234 (1980-102G) launched on 1980 Dec 23; initial orbit: 114.67 min, 74.°.01, 1477 km, 1403 km; transmissions: none reported. Military communications satellite.

Cosmos 1235 (1980-102H) launched on 1980 Dec 23; initial orbit: 114.70 min, 74°.02, 1463 km, 1420 km; transmissions: none reported. Military communications satellite.

Prognoz 8 (1980-103A) launched on 1980 Dec 25; initial orbit: 5688.14 min, 65°.83, 19737 km, 979 km; transmissions: 928.400 MHz. Solar research and forecasting satellite.

Ekran 6 (1980-104A) launched on 1980 Dec 26; initial orbit: 1436.11 min, 0°.09, 35893 km, 35688 km; transmissions: 702 to 726 MHz, 714.000 MHz. Television relay satellite at Statsionar T location over 99° East.

Cosmos 1236 (1980-105A) launched on 1980 Dec 26; initial orbit: 89.88 min, 67°.13, 365 km, 171 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1237 (1981-01A) launched on 1981 Jan 6; initial orbit: 90.35 min, 72°.88, 386 km, 195 km; transmissions: none reported. Recoverable reconnaissance satellite.

Molniya 80 (1981-02A) launched on 1981 Jan 9; initial orbit: 718.10 min, 62°.79, 39926 km, 449 km; transmissions: 3650 to 3700 MHz, 3750 to 3800 MHz, 3850 to 3900 MHz. Molniya 3-class communications satellite.

Cosmos 1238 (1981-03A) launched on 1981 Jan 16; initial orbit: 108.96 min, 83°.01, 1951 km, 404 km; transmissions: none reported. Military research satellite.

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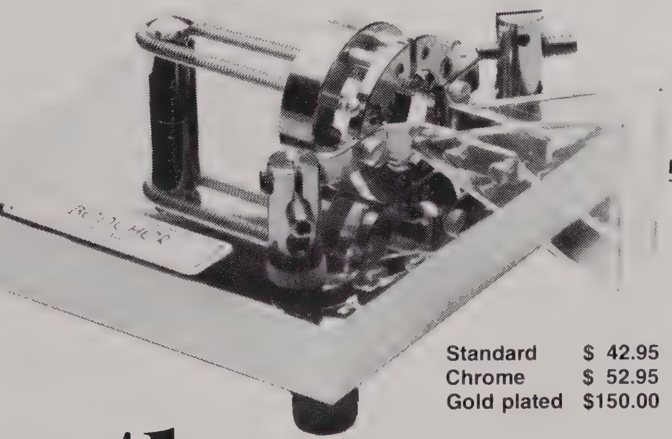

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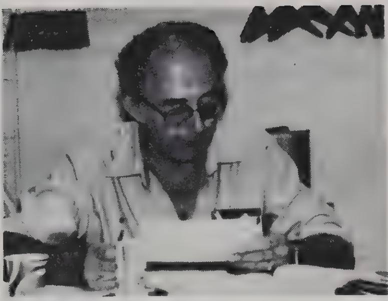

G3IOR

Worldwide Satellite Activity

By Pat Gowen, G3IOR*

Again I have to start by apologizing for the rather low level of activity evidenced on our Satellites since the last report. It was hoped that the longer periods of darkness in the Northern Hemisphere would have induced more action, but the high level of ionization, especially the marked peak in December, is still evidencing severe Mode A downlink attenuation for those operating in daylight paths. From those who were active, very few reports have arrived, with the bulk of input still coming from Europe, with nothing from Asia, Australasia, South America, and only one report from North America.

In an effort to encourage activity, AMSAT-UK sponsored an activity week from 0001 17 November to 2359 UTC 23 November, which noticeably encouraged an enhanced degree of the activity desired. Points were awarded for both QSO's via the satellite and for telemetry reports, and the ground rules expected an abidance with the 100-watt erp maximum rule as a signed declaration to comply. The winners were Andrej, OK3AU, with the transmitting prize for 588 points, and SWL Birger Lindholm of Finland with 173 points for reception only. They both receive a genuine English Pewter beer-mug, suitably engraved, on a polished wooden base for their efforts. Although initially organized as a purely UK event, International interest was evoked, as evidenced from the entrants being in order of score OK3AU, G4CUO, 9M2CR, G3UYM, G2UK, VE2QO, VE5JQ and JE1SPY entering the transmitting side, with Birger and JR6RNH in the SWL section. Ten check-logs were received, three of which were entries lacking the power-declaration. It is hoped that AMSAT-UK will run a similar event soon, with lots of advance publicity to really bring about the level of activity desired.

With the sun now decaying in its cycle, and the consequent improved path and the decrease of much of the terrestrial QRM from fm'ers and bc harmonics, an increase of occupancy of the Mode A band by a good distribution of countries and callsigns will come about once again.

Mode J activity is on the increase, no doubt helped by a proliferation of gear being made ready for Phase III. The 435 MHz downlink has been the least affected by the dense ion levels over the past year.

Mode B, despite its flat battery, thanks to it's positive power-budget, is still providing excellent communications, with new stations still appearing among the ranks of regular users. And perhaps the surprise of the period was the hearing of RS-1 by Bernie, W9KDR when the battery was long said to be quite dead. At first many thought that this was an early hearing of the anticipated RS-3 satellite, up and awaiting turn-on on a suitable calendar day. Others thought that it may have been a further ground test of a future satellite from Moscow, although propagation was all but impossible between UA3 and W1 at 0100 UTC, quite apart from the fact that Bernie heard a PA0 aboard the transponder. Confirmation of Bernie's findings were verified by OH-SWL Birger, who did a stalwart job in identifying the path and the doppler, reporting the signal as weak, but definite, as the RS-1 TLM format on 29.400 MHz.

Keep listening, fellow enthusiasts, you may hear it or you may be the first one to discover RS-3.

On the subject of general activity over the long term, Walt, W4DWN, has worked all of South America with the exception of CE and CX among his thirty-eight countries and forty-eight states confirmed by satellite. In this part of Europe, only the North-Eastern edge of South America is accessible, with PY, FY, PZ, 8R1 and YV having been worked to my knowledge. Africa could do with more representation, as only SU, CN, 6W8, 9L1, 9G1, TU, 5V4, ST2, 5Z4, 5X5, 9X5, 5T5, EL, EA8, CT3 and TR8 have been worked from here, although ZS, ZS3, ZE, A2, S79 and 7P8 have been reported active.

In Asia, worked from Europe, the following have been on OSCAR or RS: AP2, JA, JY, UA9/0, UG6, UH8, UI8, UJ8, UL7, UM8, VU, 4W1, 4X, and 5B, with 9M2, DU, HS and VS6 reported. A4 and A9 have been activated in the past.

In Europe, all of the sixty-two countries are, or have been made active, with the exception of JX, SV (Dodecanese), SV (Mount Athos), TA, UK1 (Franz-Josef), UD6, UF6 and ZA.

It appears that all countries in North America have been active, though confirmation would be appreciated. At this time little idea is held on what may have been on offer in Australasia and Oceania. It would be very appetizing to know what Phase III has in store for those seeking to extend their horizons! Also, while on the subject of North America, G6RH has now worked forty-one U.S. States, and is looking for La. and Ark. G3IOR also has 41 worked, but only 33 QSL'd, needing cards from Ark., Maine, Mo., Neb., Oregon, S. Dak., Tenn., and W. Va. QSO's with Ariz., Hawaii, Idaho, Nevada, New Mex., Texas, Utah and Wyo. are unlikely from my QTH in the extreme East of England.

LA1WF is QRV on Mode J for W/VE, and has heard good signals from VE2LI.

The "V V V de I5B FD25H" heard on 145.958 MHz appears to be an Italian beacon in the AMSAT-OSCAR uplink band, clearly audible on quiet Wednesdays.

The G8 plus three letter calls have run out at G8ZZZ, and new vhf 'B' licenses are being issued with G6 plus three letters, not to be confused with G6 plus two letters, who are pre-1939 operators.

GM3RFR, Sam, at Baltasound, in the most Northerly of the Shetland Islands hopes to be QRV on OSCAR soon now.

Jack, G4JJ, has now worked his hundred, but has only 90 confirmed despite many direct request for needed cards.

JA8DXB went to the most Northerly tip of Japan as JA8FXG, and managed to bridge that gap by working several Europeans, including G6RH for Bob's first JA.

OSCAR antennas at G4CUO. This view shows a 12-element "XY" for 432 MHz Mode B uplink on a common mounting with an 8-element similar array for both Modes A/J and a Mode B downlink.

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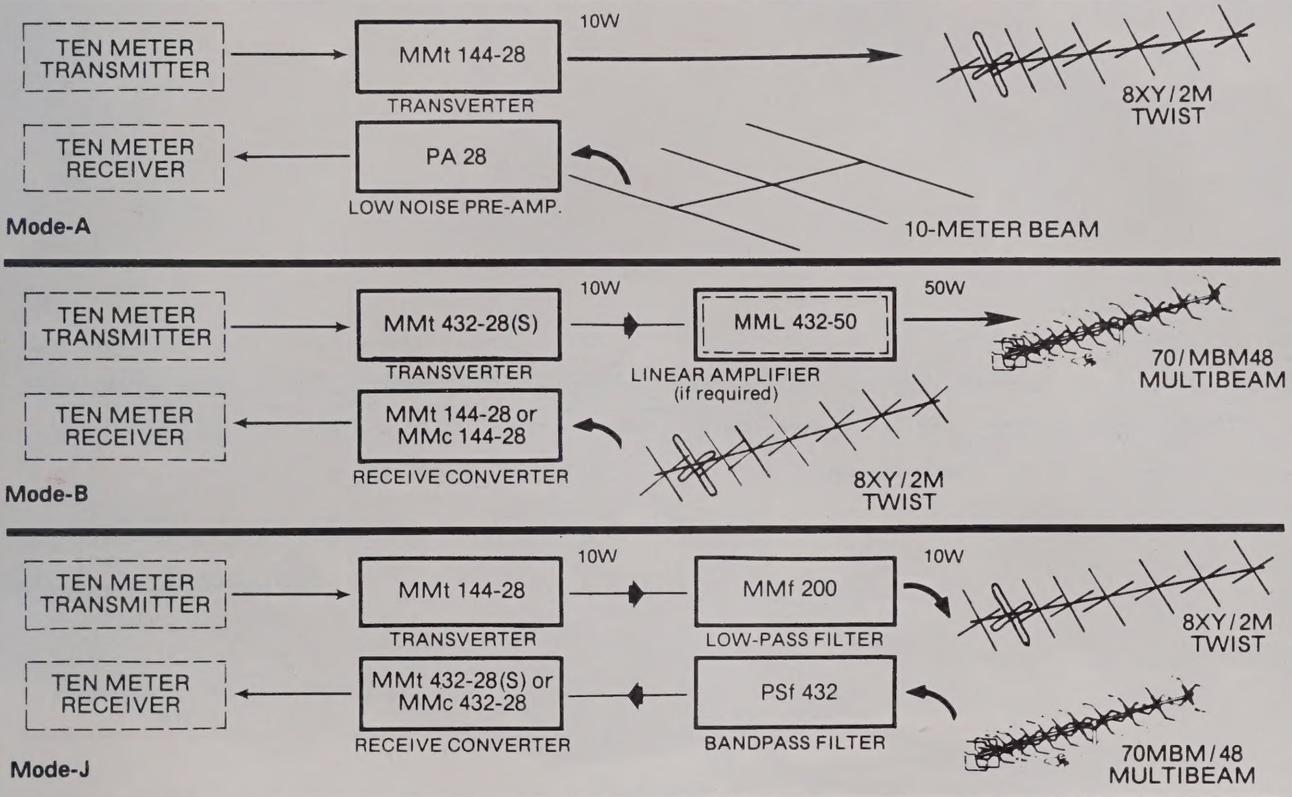

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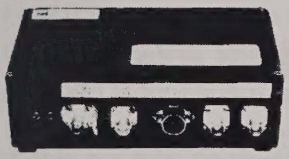

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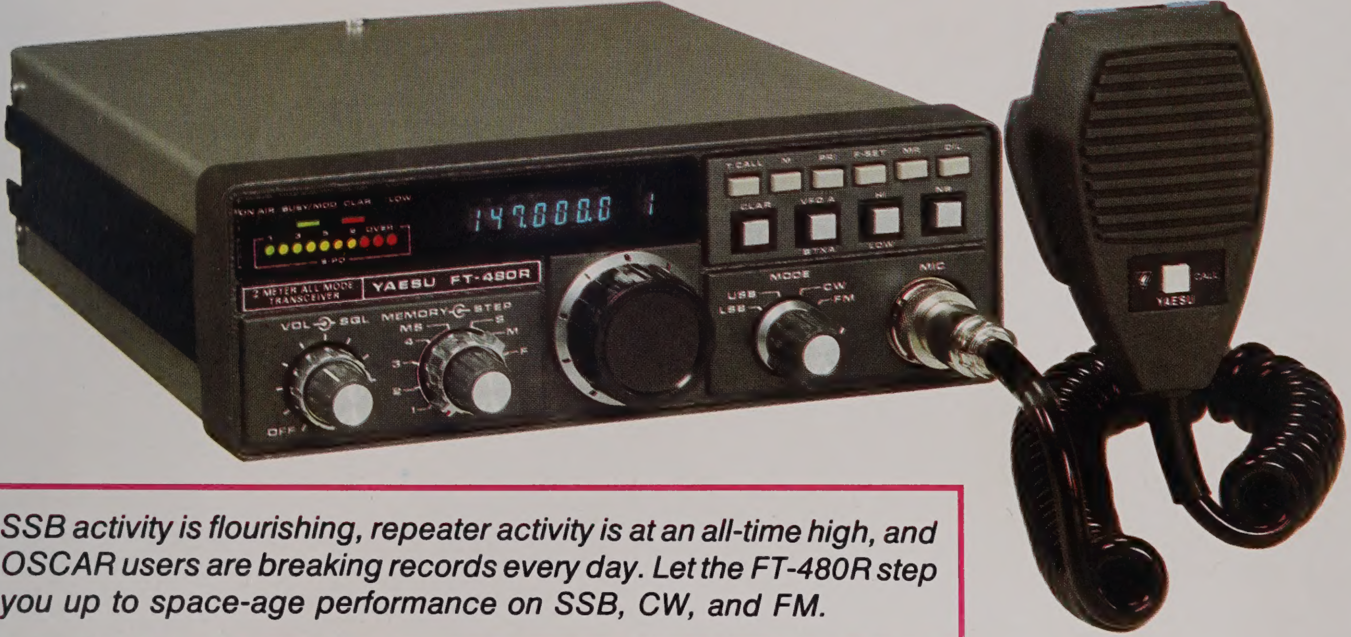

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Lunar's transverter modules, on the other hand, start with the basic down converter for receive and up converter for transmit. Selecting an appropriate local oscillator module determines the band. Additional modules are added to achieve desired receiving NF and/or output power. Changing the local oscillator module changes the band. Pre amps you already have or might build may be used as desired, similarly, for the transmit side.

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Some examples of expected performance using Lunar modules.

EXAMPLE 1

Selected modules:
DC 28
LO 28/144
UC-VHF
PAD 144
PAM 144

This combination gives you:
RF: 144 to 146MHz
IF: 28MHz to 30MHz
Conversion Gain: 25dB
Overall NF: 2 dB nom. 1.6 dB typical
Image Rejection: –30 dB typical
LO Purity: –50 dB max. all spurs & harmonics
Drive 28MHz: 1 to 5 mW
Power Output: 20 watts min.
Operating Voltage: 24VDC @ 2.5 amps. nom.

EXAMPLE 2

Modules added to Ex. 1
LO 28/220/222
PAM 220
PAD 220

This gives you:
RF: 220-222, 222-224MHz
Conversion Gain: 22 dB
Overall NF: 2.5 dB typ., 2.2 nom.
Other specs. remain the same.

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